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## VIEWS, NEWS AND INTERVIEWS.

Henry Villard is said to be a man with a total lack of appreciation for humor. This story is told of him as happening when he was president of the old Edison General Electric Company. Mr. Villard got the idea that the Edison Company ought to build an electric locomotive. He went to Thomas A. Edison and asked him to design one. Mr. Edison gave him his reasons for not wanting to undertake the task and refused to do it. Mr. Villard then ordered ten of the engineers of the Northern Pacific Railway to submit designs for electric locomotives, intending to have Mr. Edison combine the best points of all into one. The drawings and specifications arrived in the course of time and made a formidable mass of data. Mr. Villard had it all sent to Mr. Edison with the request to evolve a design from the plans. Mr. Edison replied by letter to the effect that "the only man who could design an electric locomotive from this stuff was crucified over 1,800 years ago." Mr. Villard soon after met Mr. Edward H. Johnson and told him of the trouble he had been to and that Mr. Edison had refused to make the design.

"And do you know, Johnson," said Mr. Villard in conclusion, "Edison said that all those Northern Pacific engineers ought to be crucified."

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There is a likelihood that a high-speed electric railroad will be built between Brussels and Antwerp in time for the Belgian Exposition. The daily traffic requires 16 express trains each way on the present steam roads. The route is direct and practically level. It is proposed to run a single electric car, holding 60 people, every 10 minutes, and making the trip in 20 minutes, at a speed of about 60 miles per hour. The cost of the road is estimated at about $2,200,000.

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The city statistician of Chicago reports that there are 150 establishments for "electric lights, works and materials" in that city.

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A charge of the larceny of some electricity, amount not stated, was the peculiar complaint made against Edward Gardner in Jefferson Market Court, New York, last week, and another charge of assault was also made against him. Gardner is the manager of a bicycle exhibit in Madison Square Garden, and, being desirous of running a bicycle by electricity, he tapped an electric light wire. Among the spectators one night was Frank Martin, an inspector for the electric light company, who saw the electric bicycle and cut the wire that furnished the motive power. Then Gardner hit Martin, and was arrested. While Justice McMahon was considering whether the larceny charge would stand, the two men patched up the difficulty, the complaints were withdrawn, and Gardner was discharged.

A millionaire of Vienna has left provision in his will for the constant illumination of the vault wherein he now lies. An electric light is to be kept burning for a year, and even the coffin is to be lighted in the interior by electricity.

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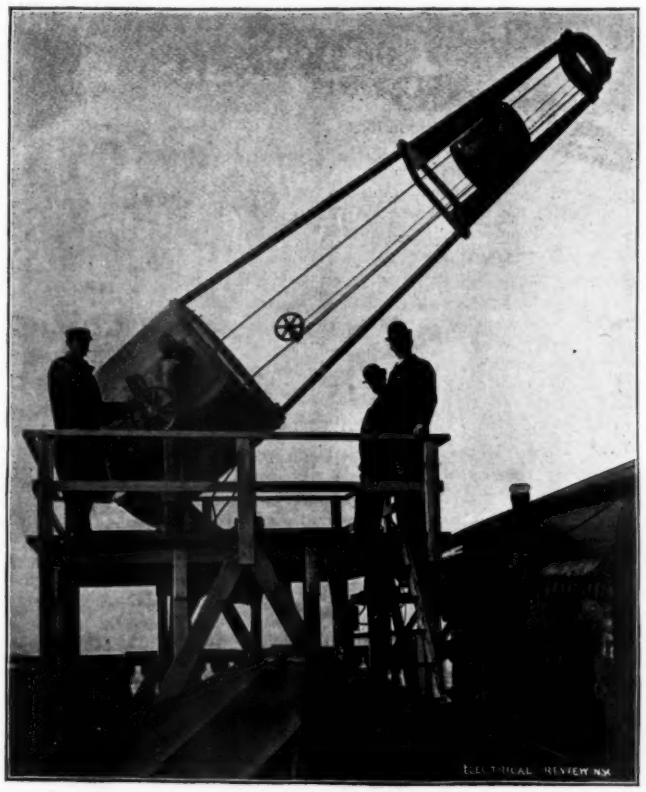
The Nassau Electric Company has filed a claim with the New York City Comptroller of $392.80 for loss of electrical goods which the company alleges were stolen from their offices by city firemen on duty at a fire in the Cornell Building, No. 137 Centre street, on December 2.



AN ELECTRIC CLOUD PROJECTOR.

The children of a Connecticut man are endeavoring to prove him to be of unsound mind. As a part of the evidence, one son testified that his father at one time thought that his paralysis could be cured by electricity, and that he forthwith procured an electric plant, consisting of a four horse-power engine and a dynamo. An elevator and electric lights were put in and operated by this plant, and the son was put to work in the cellar to look after the machinery.

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Two electricians at Orange, N. J., were severely burned by the explosion of a kerosene lamp which they were using as a source of light while repairing a dynamo. This looks like vindictiveness on the part of the kerosene.

### Judge Colt Grants a Motion Against the de Khotinsky Lamp.

Judge Colt, of the United States Circuit Court, on January 9, sent down a decision in the case of the Edison Electric Light Company *et al.* against Achilles de Khotinsky *et al.*, which was a suit in equity brought by the plaintiffs for alleged infringement on the Edison lamp. The decision in full is as follows:

The defendants do not disclose by their affidavits the kind or the amount of vapor which is inserted in the glass bulb of their lamp. From all that appears, therefore, the defendants' lamp has the vacuum called for by the Edison patent, although it may contain in addition a small amount of some kind of gas or vapor.

Under these circumstances it would be improper for the Court to enter further into the consideration of the question sought to be raised by this motion.

As the proof stands, I am of opinion that the defendants' lamp contains all the elements set forth in the second claim of the Edison patent. Motion granted.

### Too Cheap at That.

Those proposed slot telephones will charge us a dime for the pleasure of hearing "Central" say: "They're busy, now. Call 'em again."—*Chicago Post.*

## AN ELECTRIC CLOUD PROJECTOR.

AN INTERESTING DEVICE NOW IN SUCCESSFUL OPERATION IN NEW YORK—INCEPTION OF THE IDEA—EXPERIMENTAL WORK—THE MT. WASHINGTON PROJECTOR.

There is now installed and in successful operation on top of the World Building, New York City, a cloud projector used for throwing advertising signs on the clouds or on tall buildings, which is attracting a great deal of attention. The illustration herewith shows the apparatus complete. It was designed and installed by Mr. L. H. Rogers, assistant manager of the Brush Electric Company, of Cleveland, O. Mr. Rogers, after several years of experimenting, has produced an entirely successful apparatus for accomplishing the desired purpose.

During the years 1890, 1891 and 1892 L. H. Rogers was selling agent for the General Electric Company in the New England States. Traveling through the White Mountains it occurred to him that some lofty mountain peak would be a fine place on which to locate a search light. It was his idea that a search light had never had room to show its power from the fact that when located upon an eminence of an inconsiderable height, the beam of light could be seen distinctly as far as the curvature of the earth would permit.

With this thought in mind, therefore, he installed the largest light in the world upon the summit of Mt. Washington during the Summer of 1892. The results proved the correctness of his idea. This light on Mt. Washington was seen 140 miles away, and communication was established with Portland, Me., a distance of over 70 miles away, intelligent conversation being held by a system of long and short flashes, using the old telegraph alphabet, similar to the Morse, with the exception that the spaces were eliminated. The return message from Portland was received direct by telegraph, an instrument being held in the hand of the operator who was working the signaling device on the search light. Mt. Washington is surrounded by large and elegant hotels, which, during the Summer season, are filled with guests from all parts of the world. In order to reach all points on all sides of the mountain it was necessary for Mr. Rogers to raise the observatory tower about 50 feet. As the wind record on the summit of Mt. Washington is 176 miles an hour, aerial construction is attended with some few difficulties. It was necessary to use timbers nine inches square, strapped together with strong bands of iron, no nails at all being used in this construction. When the tower was raised, steel cables one inch thick were attached to each corner at the top, the other end being firmly embedded in the rocks below. Standing upon the top of this tower, one gets probably the most gorgeous moun-

tain view in America, if not in the entire world. The sensation of standing on this extreme point, the highest in the Northern Atlantic States, with a revolving search light at your command and realizing that with this great white arm of light it was possible to actually touch any house, tree or spot of ground within range of your vision, was sufficient to make one feel that electricity was indeed far reaching in its results.

Again, as it became dusk, the operator on this tower realized that hundreds of thousands of eyes were centered upon that one single spot, watching for the flash or wink of this great luminous mountain eye, which had recently come among them. Numbers of letters received daily at the time the light was in operation testified to the fact of its universal interest and its intense power. One letter said: "I read the pages of a book distinctly from your light last night when you had it pointing towards Littleton." Littleton is 20 miles air line distant from Mt. Washington. From all points surrounding the mountain came letters, inquiries and statements regarding the marvelous power of the light.

It was during the operation of this light in the Summer of 1892 that Mr. Rogers began to study the clouds and to invent some method of casting legible lines upon them. Subsequently, at the end of the Mt. Washington season, October 1, 1892, he removed the search light and electrical apparatus from the summit of Mt. Washington to Manchester, N. H., where it was installed on the top of a prominent building in the center of the town. Mr. Rogers there and then began his active experiments of throwing images long distances, which experiments have resulted in the practical cloud projector, which is now located on top of the World Building, in New York City. These early experiments were attended with the greatest difficulties, and were, for the most part, very discouraging. The first idea was to adopt the lines already laid down in magic lantern process. A pair of condensing lenses, the largest that could be obtained in the United States, were therefore tried in order to obtain the cone of light which is necessary to illuminate the lantern slide. It was soon learned, however, that condensing lenses were entirely impracticable. The largest condensing lenses that could be obtained were 14 inches in diameter, and as the beam of light that would strike them was 30 inches in diameter, it was obvious at once that special lenses would have to be constructed for this work. These special lenses would, of necessity, be at least 30 inches in diameter, and in order to cause the cone of light to reach its apex within a working distance from the apparatus, the condensing lenses of this large diameter would necessarily have to be so thick that a large proportion of the light would be absorbed in passing through them. As great intensity of light was the first requisite, it was at once seen that condensing lenses, and, therefore, the old magic lantern formula, would have to be abandoned entirely.

After considerable experimenting the cone of light was obtained by changing the position of the arc lamp and reflector as related to each other. The exact position of lamp and reflector cannot now be given. After the cone of light had been obtained the experimenting or trouble had only begun. Mr. Rogers corresponded with all the lens manufacturers of the country, all of whom replied that they had no lenses for the work he desired to do or any data which would throw any light upon the kind of lenses to grind for him. The greatest distance which perfect images or legible lines had been thrown up to this time was 80 feet and this had been done with condensing lenses, or the common magic lantern. Mr. Rogers also wrote professors eminent in this line of work, but received no intelligent responses from any, with the exception of Professor Dolbear, of Tufts College. He called upon Prof. Dolbear and found that he was heartily in sympathy with this idea and believed that it could be accomplished. From that time on he suggested ideas to Mr. Rogers which were very valuable and which aided him largely in his task of projecting images miles instead of feet.

It was decided at that time that there should be several lenses, through which the beam of light should pass, besides passing through the lantern slide, or original picture. It was also then surmised that the outer lens should be some considerable distance from the inner lens, but just how far it was absolutely impossible to tell, except from actual experimenting. Certain lenses were procured and after the cone of light was established, the lantern slide and inner lens attached to the front of projector, the outer lens would be held in line by someone on a ladder, the ladder being held by several others. This was a very unsteady arrangement at the best, but what made it so discouraging was the fact that it was even with the longest ladder impossible to get the range of the beam of light much above the horizon. Experiments were carried on in this crude manner slowly during the Winter of 1892-93, and enough was ascertained to convince Mr. Rogers that it was possible to accomplish the feat desired. Quite a few facts, however, had been definitely determined. It was ascertained that almost any surface was suitable for a screen, provided that it was not of a nature which would refract or absorb the light. The unevenness of the screen was found to be no objection whatever. A letter, part of which was on the dead branches of trees, the other part on a hillside quite a distance beyond the tree, appeared as a letter upon a plane surface to the eyes of the beholder. Words put upon the corners of buildings, also appeared as though thrown upon plane surfaces. When the beam of light was directed over a chimney, any slight issue of steam coming out of the chimney would cause the word, of whatever character might be upon the lantern slide, to jump into prominence so as to present a very beautiful appearance to the eye, the steam or screen being invisible. At one time the word which was on the lantern slide was plainly visible upon a building about two thousand feet distant; the beam of light happened to be so direct as to pass over several different chimneys. It happened that a slight issue of steam came from each of the chimneys, first from one and then from another, and sometimes from all at the same time. As the white vapor would come from the chimneys, the word which was on the lantern slide would appear over that chimney, and it was a peculiar sight to see these legible lines skipping about, apparently in the clear atmosphere, in such a fashion. At one time six different and separate words were counted, while at the same time the word remained perfectly legible upon the building beyond. The explanation of this is that the vapor which issued from the chimneys consisted of finely divided moist particles which intercepted a certain number of the rays of the intense beam of light back to the eye, while at the same time the said particles were not close enough together to prevent other rays of light passing between them to the finer divided particles over the next chimney and so on until the building was reached, the light being of sufficient intensity to illuminate all of the matter touched by the rays.

The light was next moved to the top of the Grand Opera House, Boston, Mass., where it was run as a search light during part of the evening, and where the experiments were continued each week or perhaps month, bringing some slight improvement or some known fact to add to those already obtained. It was here that the first defined ring of light was put upon a cloud. This fact had definitely decided the matter in Mr. Rogers' mind, and he thereupon determined to construct apparatus which would be adjustable in all directions and which would maintain the outer lens in a perfect alignment with the lantern slide and the other lenses, regardless of to what point of the earth or heavens it was directed.

The experiments up to this time had proven so much of a success that Mr. Rogers was confident of the curvature of the lenses necessary and of their location in order to accomplish the perfect casting of images upon the clouds. He therefore ordered the number of lenses made upon his information, and with these the definite defined ring of light was obtained on a cloud from the roof of the Grand Opera House, Boston, Mass. Having established the fact definitely in his own mind, he made an arrangement with Mr. Elmer A. Sperry, of Cleveland, Ohio, for building such a piece of apparatus and outrigger as would hold the lenses in position and be adjustable under all conditions. The apparatus was then moved to Chicago and placed upon the roof of the building at Thirty-ninth street and Stewart avenue, formerly occupied by the Sperry Electric Company. Mr. Sperry then constructed at first a crude piece of apparatus made of timbers, which held the lenses in position and which was to some degree adjustable. With this apparatus and with the lenses which had been constructed under Mr. Roger's direction, words and pictures were for the first time in the history of the world thrown upon the clouds August 16, 1893. During the succeeding month or six weeks a number of Chicago parties were invited to witness this cloud projector operate, and a large number who did not understand what was going on read not only the answers but also the questions "in the stars." Mr. Sperry then designed the large steel structure which is at present on the roof of the World Building, and which is the only structure of its kind in the world to-day.

It will be observed that these projections are obtained by entirely new processes, and not by the well-known magic lantern or stereopticon formula, by which formula the throwing distance is decidedly limited. The outer lens is, of course, a very long focus lens, and from this fact any unevenness in the screen does not render part of the image blurred, which is the case with short focus lenses. Therefore, when the head of Cleveland is on the clouds, his mouth may be upon delicate, downy vapor, his cheek upon hard unresisting raindrops, and his brain in a whirling surging mass of dark evil matter, while to the eye of the world his picture is presented as a calm, everyday individual.

The clouds may be tossing and tumbling in a veritable gale of wind and yet any character thrown thereon will appear to those below just as if the image were thrown upon a solid white screen.

The lamp, reflector and all electrical apparatus used in the projector were manufactured by the General Electric Company. Mr. Rogers extends his thanks to Prof. A. E. Dolbear, of Tuft's College, Mass., for his valuable assistance, and to Mr. Wilfred A. French, of Washington street, Boston, and Professor Pickering, of Harvard Observatory, for the loan of lenses and the kind interest which they took in the matter during the early experimenting.

## A New Electrical Advertisement.

One of the most unique advertisements which may be seen in New York city is now being maintained by the Union Square Theater. It consists of a splendidly finished wagon, capable of holding 64 chloride accumulator cells. These in turn supply lamps placed on the wagon and the trappings of four spirited black horses. Two men accompany the wagon, and as the entire outfit passes through the prominent streets of the city, it is the object of every one's admiration. We are informed by Mr. Frank Haines, the engineer, that the cost of maintenance is about $30 a day, and the cheapest part of the whole equipment is the maintenance of the electrical apparatus. The lamps used are 30 volts, and the entire apparatus gives the best of satisfaction. That the expense of this advertisement is a good investment, may be at once perceived when it is realized that partially as a result of this advertisement the entire house is filled four times a day.

Put an electric motor under the Wilson bill. Then adjust the trolley and turn the current on.—*Atlanta Constitution.*

## The Theory and Design of the Closed Coil Constant Current Dynamo.

READ BEFORE THE ELECTRICAL SECTION OF THE FRANKLIN INSTITUTE, DECEMBER 26, 1893, BY HENRY S. CARHART.

Constant current dynamos for arc lighting have been in practical use for the past 15 years. Most of the public lighting by arc light service has been done with dynamos of the open coil type. They secured the field at an early day in the development of this branch of electrical industry, through the inventive genius of Mr. Charles F. Bush and the splendid ability of his business associates. This success was repeated a little later by the equally brilliant achievements of Professors Thomson and Houston, and the phenomenal management of the company formed to exploit their patents. Aside from any question of inferiority, it is therefore easy to see why the closed coil dynamo for constant currents has remained so long in the background. It has not received the attention to which it is justly entitled, and has not been investigated with the thoroughness and skill which it merits.

It is not my purpose to draw any comparisons between the open and closed coil armatures. The former is entitled to that consideration which long continued and satisfactory service in public and private illumination has earned for it. But the latter is making its way into public favor, and it has certain peculiarities which make it an interesting subject for study. If I were to draw attention in this paper to comparisons between dynamos of different type, it would be between those for constant potential and those designed for constant current, both with closed coil armatures. For in almost every particular the latter is diametrically opposite to the former. The one is designed to give a constant potential, the other a constant current. One is shunt or compound wound, the other series wound. In the one the resistance of the armature is as low as possible in comparison with the field; in the other the armature resistance is relatively large compared with the field. The one has a sensitive field and is worked below the saturation point; the other should have a stable field which is worked well up on the saturation part of the curve of magnetization. Ideally the characteristic of the one is a horizontal line; that of the other, a vertical line. In the constant potential machine the brushes are set only slightly in advance of the theoretical neutral line or plane; in the constant current dynamo the brushes may be at any point on the commutator, according to the load, while the neutral plane remains fixed. When the load decreases with the one the brushes if moved at all are rocked backward for sparkless commutation; when the load decreases with the other the brushes are rocked forward for minimum sparking or even sparkless commutation and constancy of current. When the load increases on the one it governs by an increase of induction from an increasing field; when the load increases on the other it governs by decreasing the counter electro-motive force in the coils between the brushes and the neutral plane. In the one armature reaction is purposely reduced to the smallest dimensions; in the other it is purposely made of considerable dimensions. In these comparisons it is assumed that the speed is constant in both cases. If some of these statements are not self evident they will be supported, I hope, by subsequent portions of this paper.

### THE NEUTRAL PLANE INDEPENDENT OF THE PLANE OF COMMUTATION.

By neutral plane is meant a plane passing through the axis of the armature, and so situated with reference to the poles of the field magnet, that when a coil of the revolving armature is carried across it the electro-motive force generated changes direction. This plane intersects the armature in a straight line, but it may broaden out more or less into a surface of small lateral dimensions.

The plane of commutation is a plane passing through the armature axis, and the points of contact of the brushes on the commutator. It is the plane joining the poles of the armature considered as an electro-magnet. This latter plane, of course, shifts with the brushes, since the poles of the armature are the points at which the current enters and leaves the armature, and these are necessarily the points or surfaces of contact of the brushes with the commutator, assuming that the connections from the armature to the commutator run directly out parallel to the shaft. To state the proposition now

under discussion in the form of a question, does the neutral plane shift when the brushes are shifted forward or backward? If we were to make answer from the assumption that the resultant of two impressed magnetizations or magneto-motive forces may be obtained in the same manner as the resultant of two forces by means of the triangle of forces, we should probably conclude that the neutral plane rotates forward with a forward movement of the brushes. But experiment along several different lines shows that this conclusion is in error. If we were to apply to the solution of this problem the principles derived from constant potential machines we should be forced to the conclusion that, to maintain sparkless commutation at the brushes, the lead of the brushes beyond the neutral plane should be constant, since the current remains constant; and therefore that any attempt to govern for constant current by rocking the brushes must be attended by destructive sparking, unless at the same time the field is greatly modified. But these conclusions are also erroneous. We must therefore first establish the facts and then make a theory to fit them.

The fixed position of the neutral plane I have determined on a ten (10) light machine in two different ways.

First Method—Four turns of No. 16 silk-covered magnet wire were wound around the armature ring as an exploring coil. One end of this coil was soldered to a copper band or ring fastened on the commutator and insulated from it by several thicknesses of mica. The other end was soldered to a piece of brass let into a fibre collar placed around the commutator. One extra brush was fastened to one of the main brush holders and rested on the copper band. The other extra brush rested on the fibre collar and could be attached to any point of a circular scale made concentric with the commutator. A twisted cord ran from these two brushes to a telephone at some distance. When the dynamo was running the movable brush, which rested on the fibre and made contact with the brass strip every revolution, was moved around the circle till a minimum sound was heard in the telephone. The exploring coil was then on the neutral plane at the instant when the brush made contact with the strip. Motion of the brush either way caused the sound to increase in loudness. The position of the exploring coil for minimum sound was to be found about 5° in advance of the normal plane intermediate between the pole pieces; and its position did not change from full load to no load as far as could be detected by this method.

Second Method—To the brush holders was attached an insulating ring, slotted on the periphery at every 10 degrees on a milling machine. It was made as nearly concentric with the commutator as possible. A third brush holder was placed in the successive slots, and the potential difference between it and one main brush was measured in its several positions. These measurements gave the integrated potential difference between the main brush and successive points on the commutator all the way round the circle and back to the starting point. This was done with no load or nearly short circuit, with a load equivalent to three lamps, and finally with a load equivalent to nine lamps, the current being 10 amperes in each case. The results in the first two cases are plotted round a circle in Fig. 1. Positive values, or those in which the potential of the third brush was higher than that of the main positive brush, are set off outside the circle in the upper part of the figure, while negative values are set off outside in the lower section of the diagram. The direction of rotation is clockwise. With no load the highest positive potential was about 78 degrees behind the positive brush. From this point it fell again, and at 128 degrees it was the same as that of the positive brush. For all the coils between 0 degrees and 128 degrees the integrated positive and negative electro-motive forces exactly equal each other. The neutral plane falls evidently 78 degrees behind the brush, or the brushes may be said to have a lead of 78 degrees with no increase in sparking. A negative maximum occurred at about 260 degrees, and the potential difference between the positive and negative maxima was 644 volts. The same potential difference was found by direct measurement when two extra brushes were set at these points.

With a load equivalent to three lamps the brushes were rocked back 15 degrees to bring the current to 10 amperes. Hence, the zero of this curve begins 15 degrees back from the zero of the first curve. Again the observations are plotted and the positive maximum falls at the same place on the circle, and therefore at the same place on the commutator. The two maximum points are at about 65 degrees and 245 degrees from the positive brush, and the two potential differences are 168 and 456 volts. Their sum this time is 624 volts, a little less than with no load. With the highest load carried the brushes were rocked backward about 50 degrees further and the lead was then about 15 degrees. The extreme potential difference obtainable this time did not exceed 600 volts. So far as can be discovered from these curves the neutral plane remains fixed, while the brushes move round the commutator to adjust to a constant current. I find no evidence in them that the forward movement of the brushes to control the current causes the neutral plane to move with them. As the brushes advance with a diminishing external load they put between them and the neutral plane an increasing number of armature turns generating counter electro-motive force; and it is a striking fact that, when the field coils are not cut out, the back-turns on the armature cut down the protential difference between the brushes not by a counter magneto-motive force apparently, but by counter electro-motive force; for the maximum potential difference to be found on the commutator is no less on no load than on full load, showing that at least as many lines of force traverse the armature core with the brushes far forward and with many back armature turns as with the brushes in the position for the maximum load and with the back turns reduced to a minimum.

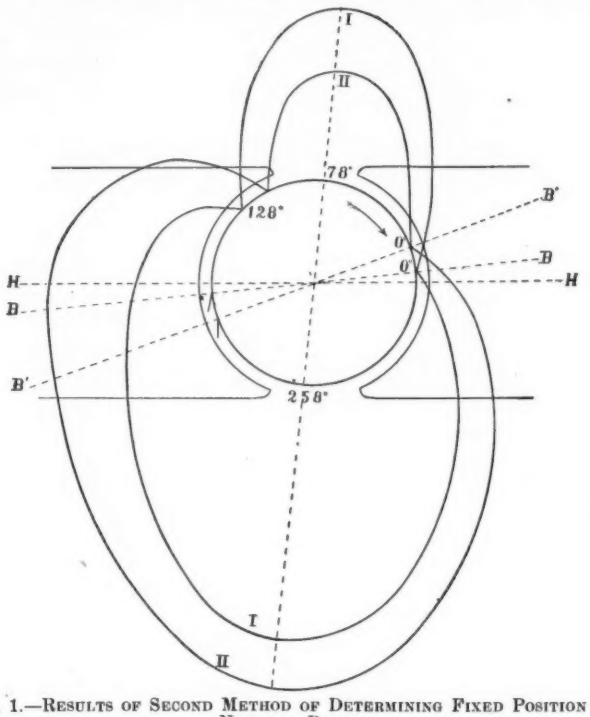


FIG. 1.—RESULTS OF SECOND METHOD OF DETERMINING FIXED POSITION OF NEUTRAL PLANE.

THREE METHODS OF GOVERNING.

Assuming still practically constant speed, we next inquire into the methods employed to maintain a constant current without appreciable sparking by rocking the brushes round the commutator cylinder.

In one machine the brushes are moved automatically by means of a small electric motor, and at the same time field coils are successively cut out as the brushes rock forward with a light load. A pair of brushes is used on each side, and they are kept at a fixed distance apart. By these combined means the machine can be run on short circuit with the normal current and without sparking.

Another system leaves the field coils constantly in circuit, but employs two pairs of brushes and varies the angular distance between the members of each pair when the brushes are moved. The movement of the brushes is effected mechanically in response to any change in the main current, till the current is brought back to the normal value. In these machines the spread of each pair of brushes, or what is sometimes called the overlap of the brushes, is lessened as they rock forward toward the polar centers. Very satisfactory results are secured in this way.

In the third class of machines only one pair of brushes is used, which lap over about two or three commutator sections, and the regulation of the current is effected solely by the movement of this one pair, without change of overlap and without disturbance of the ampere turns on the field. The brushes are moved mechanically by means of an automatic regulating devise. No less satisfactory results appear to be secured by this method than by the others, while the mechanism as a whole is somewhat simpler.

I have described these three methods for the purpose of pointing out their bearing on the theory and design of closed coil gramme rings for constant currents. The important question is not how to get the necessary electro-motive force with such a dynamo, but how to vary that electro-motive force in response to the varying demands of the external circuit, without injurious sparking at the brushes.

The electro-motive force is controlled in all three of these methods by rocking the brushes, and the other differences in the devices are made necessary for the suppression of the sparking. This brings us to a consideration of the most intrinsically interesting topic of the paper, viz., the conditions necessary to suppress sparking and the features of design required to furnish them.

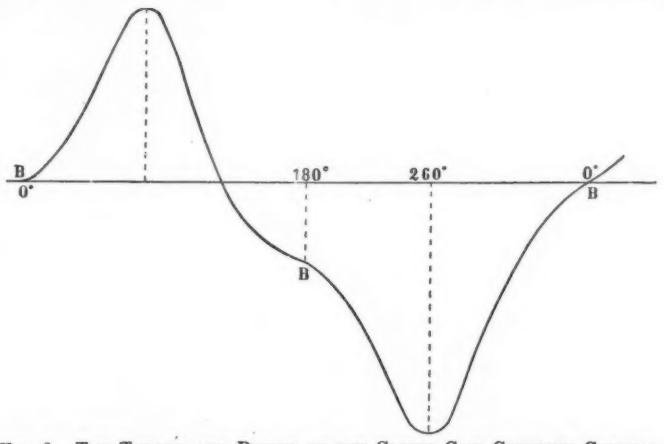


FIG. 2.—THE THEORY AND DESIGN OF THE CLOSED COIL CONSTANT CURRENT DYNAMO.

SUPPRESSION OF SPARKING.

If we assume that the armature is well balanced electrically and magnetically, and that the brushes have a proper bearing in contact with a smooth commutator, the conditions required to commute the current without sparking are known to be as follows: with a two pole dynamo, the current is divided through the armature, one-half going from brush to brush through one side and the other half through the other side. Hence, when an armature coil is carried past the brush it is transferred from the one circuit through the armature to the other, and at the same time the current through it reverses its direction. This constitutes the act of commutation. But the sudden decay of a current through a coil in one direction and its growth to an equal value in the other gives rise to an electro motive force of self-induction opposing the change. This electro-motive force will prolong the flow of the current on one side of the brush and will oppose its rise on the other side. Hence, if the coil is short-circuited by the brush lapping over the two consecutive commutator segments to which its ends are connected, even when the coil passes the neutral plane of the dynamo, the electro-motive force of self-induction produces a local current through this coil, and when the one end of the coil slips past the brush and becomes a part of the other half of the divided circuit, the current which should reverse through it meets the opposing current and breaks over the gap to the brush with a spark. Hence the commutation must not take place at the neutral plane but in advance of it, and in a field where the induced electro-motive force in the coil shall be just sufficient to offset the self-induction, and in addition reverse the current in the coil while it is passing through the brush or pair of brushes, and cause it to grow to the normal value at the instant when one end of it passes out from under the brush. The induction from the field must be sufficient to bring the one current to zero and to set an opposite one of equal value flowing in the coil, during the time it is under the brush. Then the commutation will be sparkless.

Now, if the current is kept constant in strength, the field induction required to accomplish the results described is approximately the same, whether the coil is short-circuited at one angle or another in advance of the neutral plane. It would appear at first thought that, unless the induction in every part of the field from the neutral plane to a point nearly 90 degrees in advance of it is substantially uniform, terrific sparking must result when the brushes are shifted far forward to vary the electric pressure to suit the requirements of the circuit; for, if the induction is in excess of the requirements to accomplish the result described in the commuted coil, then the current will circulate through it during the short circuit, and the rupture of this, on leaving the brush, will cause sparking. I have illustrated this action in the following manner: Separately excite the field magnets of a machine which can run on short circuit even with a forward displacement of the brushes without sparking. Then, leaving the armature on open circuit, rock the brushes forward; the sparking will increase with each advance till it becomes terrific and endangers the machine. The induction to which each coil is subjected in an excited field produces a large current in it while it is under the brush, since there is less self-induction in the coil to offset the induction from the field than there is when the machine is self-excited and working in the normal way. There is another reason, to be described later.

Considerations of this kind have led some writers to say that sparkless commutation for any position of the brushes can be accomplished only when the induction in the field is made uniform. The Statter constant current machine in England is made on this principle. Portions of the pole pieces are laboriously cut away at such points as to make the density of the lines of force entering the armature over a given angle equal. Of course a machine built in this way will permit of shifting the brushes through a considerable angle in order to vary the potential difference without introducing sparking. But while a uniform field accomplishes the result, no such uniformity is required; the same result may be secured in other ways. The first method already described weakens the field when the brushes move forward by cutting out ampere-turns in the field magnet. This reduces the induction to the proper amount at each point without changing the overlap of the brushes. It is made necessary by the very high saturation of the armature core in this machine. It has the advantage of greater economy with small loads because field resistance is cut out, but it requires a more complex arrangement of parts on the machine than suffices for the mere movement of the brushes.

## National Electric Light Association.

Master of Transportation, C. O. Baker, Jr., announces that the Trunk Line Association has granted a rate of a fare and a third on the certificate plan to Washington and return during the period of the convention, February 27 and 28 and March 1. The other passenger associations have the matter under advisement, and will probably soon render their decisions.

## OBITUARY.

The English papers contain obituary notices of the late Lieut.-Colonel James P. Bathurst, who died at the ancestral home, King Henry's Road, South Hampstead, near London, recently. He was the son of the late Lieut.-General Sir James Bathurst, K. C. B., and the grandson of Henry Bathurst Bishop, of Norwich. His son, Frederick Bathurst, is well known to the American electrical fraternity.

## Judge Shipman's Decision in the "Novak" Lamp Suit.

Judge Shipman's decision in the "Novak" incandescent lamp suit is given below in full:

UNITED STATES CIRCUIT COURT

For the District of Connecticut.

Edison Electric Light Company and Edison General Electric Company, *vs.* The Waring Electric Company *et al.*

Shipman, C. J.: This is a motion for a preliminary injunction against the alleged infringement of the second claim of letters patent, commonly called the incandescent lamp or the filament patent No. 223,898, dated January 27, 1880, to Thomas A. Edison.

The patent has been, directly and indirectly, the subject of exhaustive investigation before the courts of this country, and was carefully examined by the United States Circuit Court of Appeals for this circuit, in the case of the Edison Electric Lighting Company against the United States Electric Lighting Company. In the opinion of the court, in that case, Judge Lacombe clearly states the history and the nature of the invention, which consisted, in general, in substituting carbon "reduced in size to the filamentary form and placed in a nearly perfect vacuum, for illuminents which had previously been the subjects of experiments, a change of material which involved a reorganization of the lamp and presented the complete combination of elements, which for the first time in the art produced a practical electric light."

The second claim is thus paraphrased by Judge Lacombe:

The combination of carbon filamentary or thread-like in size and properly cabonized, used as an illuminent in an incandescent electric lamp with a receiver made entirely of glass and conductors passing through the glass, and from which receivers the air is exhausted to such an extent that disintegration of the carbon due to the air-washing action of surrounding gases or to any other cause is so far reduced as to leave the carbon practically stable.

The defendants' lamp, called the Waring lamp, is the Edison lamp, with the alleged exception that in the receiver, a nearly perfect vacuum has not been created by exhaustion of the air, but that into the partially exhausted receiver a portion of bromine gas has been introduced. This introduction of bromine and consequent lessening of the vacuum it is claimed, produce a marked improvement in the stability of the carbon and in the diminution of the blackening of the glass of the lamp.

This improved construction is protected by letters patent to John Waring, No. 497,038, dated May 9, 1893. The specifications say that the atmospheric air may be partially withdrawn by means of an air pump, and the gas is then admitted. "This gas admitted to the globe and diluted by the air remaining in them is then partially withdrawn and more gas allowed to enter, this process being repeated until the extent to which the desired gas is diluted with foreign gases has become pratically infinitesimal. If preferred, the atmospheric air may be at first exhausted as nearly as possible, and the desired gas then admitted around the carbon. The amount of gas to be admitted will in practice vary with the size of the inclosing chamber, with the nature of the gas and probably also with the nature of the other elements of the lamp." This vague description of the ultimate character of the vacuum and of the amount of "desired" gas, which was to be admitted, furnishes inadequate data by which to ascertain with precision the extent of the departure from the Edison lamp. The question naturally arises, how much desired gas is admitted, after the atmospheric air has been exhausted as nearly as possible. The defendants' affidavits state the successive steps which are taken in practice and the resultant vacuum is given in a number of the affidavits with adequate accuracy.

Prof. Appleton gives the essential features of the process as he saw it in the ordinary manufacture of the lamps, as follows: "Atmospheric air was pumped from the bulb by a mechanical pump, not by a mercury pump. Bromine vapor was allowed to fill the bulb, so that the orange red color of bromine was visible therein. Then followed pumping by a mechanical pump by which 'bromine vapor and air are to a large degree removed.' An ample amount of bromine vapor is again allowed to fill the bulb. A third mechanical pumping follows, by which 'residual air and bromine vapor are largely removed, but some bromine remains.'"

The lamp is sealed by fusing the glass opening. The general conclusions, taken by themselves, of Prof. Appleton and also of Prof. Carmjchael, both competent analytical chemists, whose affidavits are introduced by the defendants, would far from satisfy the mind that a material departure from the exhaustion, which was the result of the Edison method of manufacture, had been sought in the Waring lamp. For example, Prof. Appleton says: "My conclusions, therefore, are that the Waring Electric Company is undoubtedly introducing bromine in their lamps in the process of manufacture, that the bromine remains in them after their entry in the market; in a given bulb the quantity is small, but it is perfectly recognizable by the chemist, and it cannot in an electric lamp be fairly called unworthy of consideration."

Prof. Carmichael says: "The vacuum, as deduced from the experiments cited, is considerably less perfect than that of the Edison lamp. By the ordinary factory list of observing the duration of the vibration of the carbonized filament, the Novak (Waring) lamps, as supplied to me, appeared to me to be less perfectly exhausted than the Edison lamps, as I have ordinarily observed them in use."

Other experts upon each side of this controversy are, however, able to state with more mathematical accuracy, the exact nature of the vacuum, and they do not essentially differ in their conclusions.

The affidavit of Mr. Howell, in behalf of the complainant, after saying that all lamps exhausted to high vacuum have residual gases remaining in them, which are "not common air but are probably a mixture of gases in which hydrogen predominates," states as follows:

The vacuum produced in practice in the Edison lamps is about $\frac{1}{30000}$ of an atmosphere; *i. e.*, 29,000 out of 30,000 units of atmosphere are removed from the globe. Or, in other words, if we assume the height of a mercury column at atmospheric pressure to be 30 inches, such a column connected to one of these lamp globes will be depressed $\frac{1}{1000}$ of an inch, due to the pressure of the residual gas within the globe. A very much lower vacuum or higher pressure than this, however, can be used in practice without destroying the commercial character of the lamp, even when no special gas is introduced into the globe. A pressure which will lower the mercury column $\frac{1}{1000}$ of an inch, *i. e.*, a vacuum of $\frac{1}{30000}$ of an atmosphere, would, I believe, be sufficient for commercial purposes without the use of any of the supposedly inert gases, although a higher vacuum is more desirable.

The results of Mr. Howell's tests are as follows:

The Waring lamps contain a gas pressure which may be as high as $\frac{1}{10}$ of an inch in the case of the 16 candle-power and 25 candle-power lamps, and which runs from that pressure down to $\frac{1}{150}$ of an inch in the case of the 32 candle-power and 50 candle-power lamps. * * *

In considering the effect of even so high a pressure as $\frac{1}{10}$ of an inch, it should be borne in mind that this means a vacuum of $\frac{9}{10}$ of an atmosphere, involving the removal of 599 out of 600 parts of the air or other gases within the globe.

Mr. Thomas B. Stillman, for the complainant, found that each one of the 16 candle-power Waring lamps which he tested, contained a pressure of $\frac{1}{60}$ of an atmosphere, or a vacuum in which 665 out of 666 units of gas are removed.

Turning now to the affidavits of the disinterested witnesses for the defendant, Professors Wright and Anthony devote themselves substantially to a statement of their opinions in regard to the improved character of the Waring lamp over that of its Edison predecessors by reason of the introduction of bromine gas, which they think preserves the transparency of the walls of the lamp and the stability of the carbon. While the question of the extent of an alleged improvement upon an existing patented combination may become incidentally important in ascertaining the character of the departure from the peculiarities of the invention, which were described in and protected by the patent, it is obvious that the first and vital question is, were all the elements of the patented combination used in the second and improved invention in the manner and to produce the result described in the antecedent patent? Without, therefore, attempting to ascertain the correctness of Professor Anthony's conclusion, that the introduction of bromine into the chamber of an incandescent lamp is a new step in the art, whose results "are of the utmost importance," I shall confine myself to a consideration of the question whether before he took this step, he made use of the Edison entire combination, and whether the alleged improvement is an addition to and not a substitute for one of Edison's described elements.

The defendant's affidavits, which are of importance in this connection, are those of Professors Carmichael and Robb and Mr. Charles A. Stone. Professor Carmichael says that the Waring lamp contains residual gases which occupy about $\frac{1}{10000}$ of the whole volume of the lamp and the bromine vapor about $\frac{11}{10000}$, and together $\frac{1}{833}$. Mr. Stone places the exhaustion of the Waring lamps to between $\frac{1}{300}$ and $\frac{1}{10000}$ of an atmosphere.

The conclusion of Professor Robb, who, it is proper to say, has given more attention to this subject than has either of the other experts for the defendant, is that the bromine gas in the Waring 16 or 25 candle-power lamp is under a pressure, when the lamp is heated, of about the $\frac{1}{300}$ of an atmosphere. There is, therefore, no important disagreement between the experts on either side in regard to the vacuum in the lamps of those respective powers. The estimates vary from $\frac{1}{300}$ to $\frac{1}{833}$ of an atmosphere.

It must be observed that Mr. Howell's tests of 50 candle-power Waring lamps (not including those called lot No. 1, which turned out to be vacuum lamps manufactured by the Perkin's Company) showed a high vacuum. He thinks that the vacuum in the 50 and in the 32 candle-power Waring lamps exceeded that in those of lower power. The experiments of the defendants' experts had been limited to lamps of 16 and 25 candle-power, and therefore I shall confine myself to the results which flowed from those experiments and which, of course, I assume to be true.

The defendants' legal position is authoritatively stated in Seymour *v.* Osborne, 11 Wall, 516, as follows: "Investors of a combination cannot suppress subsequent improvements which are substantially different, whether the new improvements consist in a new combination of the same ingredients, or of a substitution of some newly discovered ingredient, or of some old one performing some new function not known at the date of the letters patent, as a proper substitute for the ingredient withdrawn from the combination constituting their invention." Their theory is that the introduction of bromine gas into a globe only partially exhausted is the substitution of a newly discovered ingredient for the air exhaustion of the Edison patent.

What Waring puts into the receiver is not of prime importance, but the question to be solved is whether he exhausts the contents of the globe, whether air, residual gases or newly introduced bromine gas to such an extent that, when the globe is sealed, he has used that part of Edison's combination to such an extent that thereby the carbon is rendered practically stable. The mere introduction of gases into the receiver is not important, but if before they have been introduced, Waring takes away the atmospheric air and the residual gases and, after the new addition has been introduced, he takes away the contents of the globe by exhaustion, so that a practical vacuum finally remains, not as high as Edison thought necessary for the spongy and porous cotton thread which he carbonized, but a vacuum which renders practically stable a carbon, filamentary in size and of whatever hard and dense material it may be composed, then Waring has taken the combination of Edison, however much he may have improved it by the residuum of bromine gas, which Prof. Carmichael estimates to occupy $\frac{11}{10000}$ of the volume of the of the lamp.

To ascertain the effect of the exhaustion by the Waring method upon the stability of the carbon, it is necessary to look at the result of Professor Robb's instructive experiments, which were as follows:

Four Perkins 25 candle-power lamps and four Edison 16 candle-power lamps were taken to the Waring factory. Two Perkins lamps (Nos. 1 and 2) and two Edison lamps (Nos. 1 and 2) were left unaltered. The remaining lamps (Perkins Nos. 3 and 4 and Edison Nos. 3 and 4) were opened and partially exhausted and treated with bromine as if they were Waring lamps in the ordinary course of manufacture. The voltage required to raise the lamps to their normal candle-power was measured.

Perkins Lamp.

| | | | |
|---|---|---|---|
| No. 1 (original lamp) | gave | 25 c.p. at | 47.7 volts |
| " 2 ( " " ) | " | 25 c.p. at | 48.0 " |
| " 3 (bromine lamp) | " | 25 c.p. at | 50.9 " |
| " 4 ( " " ) | " | 25 c.p. at | 49.5 " |

Edison Lamp.

| | | | |
|---|---|---|---|
| No. 1 (original lamp) | " | 16 c.p. at | 56.3 " |
| " 2 ( " " ) | " | 16 c.p. at | 54.0 " |
| " 3 (bromine lamp) | " | 16 c.p. at | 59.0 " |
| " 4 ( " " ) | " | 15 c.p. at | 59.5 " |

The four Perkins lamps were then run at 65 volts for 10 hours and at 75 volts for four hours. The Edison lamps were run eight hours at an average of 78 volts. The candle-power of the lamps was then remeasured at the same voltages as those at which the preceding measurements had been made, and it was found that:

Perkins Lamp.

| | | | |
|---|---|---|---|
| No. 1 (original lamp) | gave | 13.6 | candle-power |
| " 2 ( " " ) | " | 13.8 | " " |
| " 3 (bromine lamp) | " | 23.0 | " " |
| " 4 ( " " ) | Candle-power could not be measured, as filament broke a few minutes before run ended. | | |

Edison Lamp.

| | | | |
|---|---|---|---|
| No. 1 (original lamp) | gave | 6.1 | candle-power |
| " 2 ( " " ) | " | 4.4 | " " |
| " 3 (bromine lamp) | " | 9.9 | " " |
| " 4 ( " " ) | " | 11.0 | " " |

The second test was as follows:

"I took four lamps in the course of construction at the Waring Electric Company's factory and had them exhausted on the pump at the same time. Two of these lamps (Waring lamps Nos. 1 and 2) were filled with bromine and two (Waring lamps Nos. 3 and 4) with air, the degree of exhaustion being identical in all four lamps. The filaments in these lamps were intended for sixteen candle-power lamps and the voltage at which the lamps would yield sixteen candle-power was measured at the physical laboratory of Trinity College and it was found that—

Waring lamp.

| | | | |
|---|---|---|---|
| No. 1 (bromine lamp) | gave | 16 c.p. at | 118.0 volts |
| " 2 ( " " ) | " | 16 c.p. at | 115.9 " |
| " 3 ( air lamp) | " | 16 c.p. at | 128.9 " |
| " 4 ( " " ) | " | 16 c.p. at | 126.9 " |

The lamps were then run at 115 volts for 20 hours. The candle-power of the lamps were then remeasured at the same voltages as those at which the preceding measurements had been made, and it was found that—

Waring lamp.

| | | | |
|---|---|---|---|
| No. 1 (bromine lamp) | gave | 16.0 | c. p. |
| " 2 ( " " ) | " | 16.0 | " |
| " 3 ( air lamp) | " | 9.4 | " |
| " 4 ( " " ) | " | 11.0 | " |

These and kindred tests satisfy Prof. Robb that the vacuum in the bromine lamps is so poor that if the vapor in the lamps had been air instead of bromine they would have been considered worthless.

In view of the present condition of incandescent lighting in this country, I have no doubt that an Edison lamp with the exhaustion which was given in the experiments would be considered by the users of electric light as so far inferior to the ordinary standard of an Edison lamp as to be worthless, and would be discarded by those who were accustomed to the usual stability of an incandescent lamp. But these experiments show to my mind, when read in connection with the other affidavits of the defendants, that Waring intentionally used the principle of exhaustion to a generous degree, and that the vacuum ingredient of Edison was, to a large extent, employed and its benefits were partially enjoyed. Waring took the lamp which Edison gave in 1880, and which was the first practical incandescent electric light, and used all the ideas which were finally embodied in the Edison lamp, but used the idea of exhaustion to a more limited extent than the original inventor thought was necessary; nevertheless, without the large exhaustion of the atmospheric air and the gases which Waring accomplished, his lamp would be a failure. It will not be claimed that the inventor of an improvement upon a previously patented combination can use one of the patented elements in a dwarfed and incomplete way, but by its use receive the old resultant benefit, and escape the charge of infringement by reason of the low percentage of such use. The defendants' theory is that its use is so far unlike that of Edison that it can properly be said to be radically different. That theory is not supported in the Waring specification, and it does not seem to me to be supported by the facts. The statement in the specification that the atmospheric air may be at first exhausted as nearly as possible and the desired gas then admitted is significant.

Profs. Appleton's and Carmichael's affidavits show that the amount of gas which finally remains in the globe is small.

The defendants claim that the Edison patent, which was dated January 27, 1880, has expired by reason of the expiration of the British patent, No. 4576, for the same invention, antedated November 10, 1879, but not sealed and the specifications of which was not enrolled until after the United States patent in a suit had been issued.

This question was recently examined by Judge Jenkins in American Bell Telephone Company *vs.* Cushman, 57 Fed. Rep., 842. He refers to the various decisions upon the questions, and concludes that "the invention is not patented abroad before the actual sealing and issuance of the patent," and that the term "patented" as used in Section 4,887 of the Revised Statutes does not mean the preliminary proceedings, but the actual issuance of the patent under the seal of the government speaking the excercises of sovereign will, investing the patentee with the grant of a monopoly." In this conclusion I entirely concur.

The motion is granted. The terms of the order are to be settled upon notice.

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It was announced in Boston last Saturday that the defendants in the "Novak" case had secured a stay of injunction pending an appeal to a higher court. (See page 31.)

## The Cowles Electric Smelting and Aluminum Company.

To the Editor of Electrical Review:

An item has appeared in several of the trade journals lately stating that the Cowles Electric Smelting and Aluminum Company and the Pittsburgh Reduction Company had consolidated. We wish to deny this statement as the two companies have not consolidated, nor are there any negotiations to that effect pending, neither are we expecting to move our plant to Niagara Falls. Our works at Lockport are still in operation, and we are prepared to furnish aluminum and our various alloys as heretofore.

Yours truly,

The Cowles Electric Smelting and Aluminum Company.

Lockport, N. Y., Jan. 13, 1894.

## Cleveland Car Barns Burned.

The Willson avenue barns of the Cleveland, O., Electric Railway Company were burned on January 13. The fire was discovered at 3.25 o'clock A. M., and was supposed to be of incendiary origin, as the wires had been tampered with. When an attempt was made to run out the cars, it was discovered that the current had been grounded. Eighteen motors and 12 trailers were consumed. The loss is estimated at $60,000. Congressman Tom L. Johnson is one of the directors of the company.

# THE LINE REPAIRER.

THE MELTED TROLLEY POLE—QUICK REPAIRS NECESSARY—AN INGENIOUS JACK—THE NEW FENDER—SHOCKS NOT AS DANGEROUS AS SUPPOSED.

Not long ago, in the City of Churches, what might be termed the finest display of fireworks since the opening of the Brooklyn Bridge on the Queen's birthday, was seen on Fulton street, near the bridge entrance. At this point there is a great network of tracks and trolley wires, and an interesting hour may be spent watching the frantic efforts of the numerous conductors to replace the trolley pole which so often jumps the wire at the switch.

The particular inc'dent referred to attracted a great deal of attention. One of the cars came rumbling along, when suddenly it stopped and a magnificent display of blue electric sparks poured down over the car. The trolley had jumped the wire and become jammed in the iron work of the elevated railway, bringing the trolley pole at about its middle against the wire. Here it stuck, and the elevated structure being practically the return circuit, the line was short circuited at this point and the heating effect of the current began to work in the iron pole. The conductor vainly endeavored to remove the pole and succeeded, but for a moment, when it became jammed again, and once more the current flowed through the mass of iron. Gradually the pole became white hot, and after a few minutes the representation of the "pillar of fire by day," slowly melted and dropped onto the top of the car, and, of course, set the roof of the car on fire.

A heroic motorman jumped upon the roof and pouring bucketful after bucketful of water soon subdued the flames. But the car had to be moved; a trolley was improvised by sticking a switch iron into the broken end of the pole and holding it on the wire with gloved hands, while the car was backed onto a side track. This ingenious jury trolley would not stay on the wire, and showers of sparks fell all about the man. He pulled his coat collar close up over his ears, jammed his hat down over his ears and crouching low, held the pole on the wire with the bend of his elbow, until the car was backed out of the way.

The trolley end of the pole remained jammed among the iron work of the elevated railway; the car was side tracked until it was trailed up to the power house. In order to see how this and similar accidents are remedied, I procured admission to one of the line repair houses.

The scene was one of activity; accidents are constantly arising, and maimed and disabled cars are brought here for repairs. Here they are placed on the pits, which are deep trenches in which the men work under the car; but the most interesting repairs are those which have to be made along the line of the roadway.

The company owns what are termed repair wagons and emergency wagons. The latter are built on the style of the police patrol wagons; a gong on front warns the passers. The wagon is well supplied with all those tools necessary for repairs, and supplies to be used in place of those destroyed; in short, an entire outfit for a temporary repair.

Suppose a case, for instance, where from some cause a trolley wire has become snapped. The motorman, who first perceives this, telephones at the nearest station to the nearest power house. The alarm is received, the requisite information obtained regarding the cause of delay, and the horses impatient to start are rapidly harnessed to the wagon and together with a corps of linemen start for the scene of the trouble. This is done so rapidly that the men, who take a pardonable pride in their facility for rapid repairs, state that in the matter of time of exit, they can compete with the fire department.

Having arrived at the seat of the trouble, the wagon stops, and, being provided with a ladder, the workman mounts and strings the trolley wire out of the way. This prevents any block in the line, and the conductors, as they approach the break, simply remove the trolley wheel and hold it off until they reach the secure wire. The car then proceeds on its way, while the repair wagon is sent for in case the damage is more than a temporary one.

This wagon resembles, in a measure, the tower wagons used by the fire department. The platform may be elevated by means of a winch, and upon this platform the workmen obtain ready access to the trolley wire and trolley wire poles. The work, as can be readily imagined, differs but little from that done by the ordinary telegraph and telephone line repairers. Practically the same tools are used, but the joints must be made more carefully, not merely from an electrical standpoint, but from a mechanical one. For the constant wear which it receives makes it absolutely essential that the joints should be perfect in every way.

At those places where the hangers are situated, the resistance to the pressure of the trolley pole is greater, and on that account the wear and tear is proportionately increased. The joints to be made, after a break has occurred, must be reasonably smooth to allow the ready passage of the trolley wheel. It is, of course, to be regretted that a simple twisting of the wires could not be resorted to, for it would not only be expedient, but the tensile strength would be greater at that point. Such simple accidents as breaks are very easily remedied, and the wear is much less than one would at first imagine.

I am told that at the most intricate crossing, that where the "fireworks" above mentioned occurred, there has been no necessity for replacing the wire which has become worn, as the amount of copper rubbed off is comparatively a small factor. It is calculated that the life would be a minimum of two years. Where an accident has occurred to a motor car, a new and ingenious jack, devised by one of the company's employés, is brought into requisition. It consists of two stout oaken uprights, having two columns of holes placed alternately; passing between these uprights is a movable iron rod which has at a point situated about four inches from one end a swinging hook; about an inch and a half on either side of this hook two semi-circular cuts are made in the lower edge of the iron rod, these cuts accommodating themselves to an iron pin which is removable, and may be slid from one post through to the other, one pin for each column of holes. The hook is placed under the front end of the car and one of the pins is placed through the holes and underneath the iron rod. Then, as the case may be, with either a pull down or a push up, two or three workmen at the long end of the lever are thus enabled to raise the car from its truck. As soon as the car has been slightly raised the other pin is placed in the hole one higher than that before used, and thus by a step up motion the car is readily raised. It is a remarkably simple device, is cheap and easily constructed.

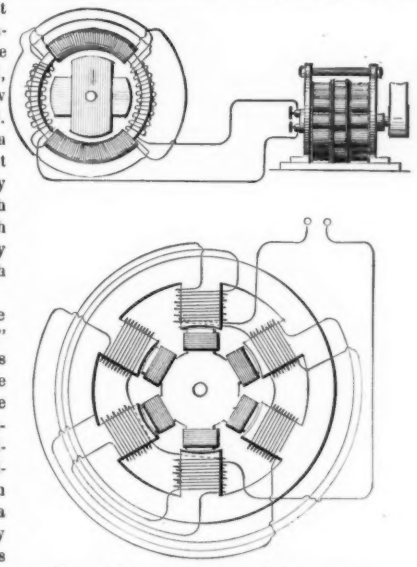
It is a fact worthy of notice that the employés in these repair shops assume a remarkable condition of inertness as soon as any questions are addressed to them. Their mind becomes an utter blank, and they have a constant habit of referring you to the individual next higher in office than they.

There is, however, one kind of accidents which cannot be readily repaired, and in order to avoid this the company are now installing on the new cars the safety fender which has been adopted by the West End Railway in Boston. This device consists of a simple latticed tray, projecting about two and one-half feet in front of a car, having a broad band of strip-iron not more than three inches in width as a border.

When this fender strikes any individual who may be unfortunate enough to stand in its track it hits him below the center of gravity, and he is supposed to drop comfortably into the fender. But if you stop a moment and think what might be the effect of such a blow coming with the momentum of one of the ponderous trolley cars, we will see that the object will be one of pity.

I asked one of the employés why they did not put a band of some yielding material, such as a pneumatic tire or a canvas pad, in front of the fender. "It would have to be a pretty large piece of canvass which would take away the shock." "It would seem to me," I suggested, "that a broken leg would be the result." "Well," he replied, "broken legs are better than broken heads, and the West End people claim that they have saved 15 lives by its use. We are satisfied with that, and it is about as good a showing as could be expected."

These fenders seemed so built that if anyone wanted to step upon them on a muddy day he would be unable to stand upright, if the car was making any headway at all. "Why not have some kind of grating," I asked, "covered, say, with rubber, which would enable a person to secure a sure foothold on the fender?" Notwithstanding the fact that the expense to the Brooklyn City Railway is of secondary consideration, it seems that cheapness in this respect should not be sought after. This, above all else, should have the closest attention, and no pains should be spared to make a safety fender as efficient and practical a device as possible. Life is not a thing to be trifled with, and the interests of the community demand that some means be provided to protect pedestrians from the swiftly moving cars. It is essentially a fallacy that persons are often seriously injured by the electric current used for street car propulsion.



TESLA SINGLE CIRCUIT ALTERNATING MOTOR.

It is true a shock would not be relished by an ordinary mortal, but those who have received the experience claim that there is no serious result arising from contact with a wire carrying such a current.

"Have you had any experiences?" I asked. Amusingly looking towards the ceiling he replied, "Well, I should say about on an average of one a month. I have been thrown from a repair wagon for a distance of 30 feet or more and I live to tell the tale. See that man over there?" and he pointed to a rather healthy looking individual. "Well one day he was ordered to clean off the busbars in a power station, but was told to wait till the dynamo had shut down before commencing. Being in a hurry to get through his work for the day he started in cleaning before the dynamo had shut down. All went well as long as he cleaned but one at a time, but suddenly his foot slipped and he grasped two, thus receiving the entire current through his body. He simply stiffened out and hung there until we could shut off the current, when he dropped from the bars, and a short nap of half an hour or more enabled him to get around on his feet the next day. Maybe though he was an exceptional case." "Do you think, however, that an ordinary individual could stand such a shock?" "Well," he replied, quoting the old adage, "Eels get used to skinning."

JULIAN A. MOSES.

## Questions and Answers.

BY OUR "QUESTION EDITOR."

TO THE EDITOR OF ELECTRICAL REVIEW:

What is the cause of the commutator blistering or burning? Condition of dynamos (No. 10) in the best of trim, run by a 75 horse-power high pressure automatic engine, with two link belts, farthest dynamo measure 15 feet from center of drive wheel to center of dynamo pulley. The other one is 11½ feet. The capacity of engine is 280 revolutions per minute, but it varies from 260 to 272, the average being 268. These are the variations given by two indicators; also the fireman allows a variation of 10 to 20 pounds.

Now what causes the burning? Is it from a back current, or is it caused by the variations of engine?

Very respectfully,

Topeka, Kas. J. H. P.

Please remember, in asking questions, to give all the data. You fail to tell what make of dynamo you have and whether it is arc or incandescent. You should also state its standard speed and its rated capacity in volts and amperes at that speed, and also the amount of work you are giving the dynamos to do. The belt distances have nothing to do with sparking. We suspect you are running arc lights and your electromotive force is higher than the machine is rated for. The trouble might be caused by any one of a number of conditions. Lamps may be adjusted for too short an arc, regulator may be out of adjustment, brushes may have too much or too little "lead," etc. In any of these the very irregular speed of your engine would probably aggravate the trouble. A fireman who allows a variation of 20 pounds steam pressure fails in his duty. Stir him up. Get your engine variations within three per cent., lamps adjusted, regulator in proper order, speed of dynamos as called for by the makers, brushes properly located, and your trouble should cease.

## Northwestern Electrical Association.

The meeting of the Northwestern Electrical Association, to be held at the Hotel Pfister, Milwaukee, Wis., commencing January 17, 1894, at 2 P. M., will last three days.

The original intention was to continue the meeting for two days, but the warm-hearted Milwaukee electricians have prevailed upon the association to remain in session one day longer to allow the members time to visit the places of interest in the city. The Milwaukee Street Railway Company has generously placed at the disposal of the association a sufficient number of cars to convey the members to all points accessible by its line.

Among the proposed places to be visited are the Milwaukee Street Railway Company's new shops, which are perfect models; the power house of the Allis Company, the Pabst Brewing Company, the Edison power station, the Siemens & Halske power station, and the Badger illuminating station. On the evening of the second day a banquet will be given at the Hotel Pfister.

## Tesla Single Circuit Alternating Motor.

In a patent issued to Mr. Nikola Tesla on January 2, entitled, "Electrical Transmission of Power, No. 311,915, originally filed May 15, 1888," is described a method of operating motors from a two-wire alternating circuit. The method employed is set forth in the two claims of the patent as follows:

1. The method of operating electro-magnetic motors having independent energizing circuits, as herein described, which consists in passing an alternating current through one of the energizing circuits and inducing by such current the current in the other energizing circuit of the motor, as set forth.

2. The method of operating electro-magnetic motors having independent energizing circuits, as herein described, which consists in developing an alternating current in one of said energizing circuits, and inducing thereby currents in the other energizing circuit or circuits, as herein set forth.

## Electric Traction in Japan.

The question of electric traction is just now disturbing the peace of mind of the progressive Japanese. A proposal has been prepared at Osaka to construct an elevated electric street railway between the north and south districts of the city. The Tokio Tramway Company has definitely decided to adopt electric traction on its lines.

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Holiday business is over, and everyone has settled down to solid, steady work. These interruptions are good in a way, but anything that tends to unsettle the regular routine is harmful, and the effect is felt for a good while after.

We are pleased to note that notwithstanding the fact that incandescent lamps are becoming periodically cheaper, their quality is becoming better, and we now hear of lamps which have average lives far above what we have been accustomed to.

Another big cut in incandescent lamp prices. We wonder how far this will go? There is a rumor afloat that in the very near future another "non-infringing" lamp will make its appearance; but notwithstanding this the standard makes retain their popularity, and will continue to do so. It pays to be known.

### *EDITORIAL SENECTITUDE.*

In a recent issue of the New York *Morning Journal* appeared an article headed "Lessons from the Trolley, by David M. Stone, the Veteran Editor," which deserves more than passing notice, as indicating a possible source of much of the twaddle which has filled the daily press against the trolley system. Here is a writer who glories in the title of "veteran editor" writing the veriest trash we have yet seen anent this triumph of electrical science and engineering. Let us examine what he writes:

"You will remember that when I held the editorial pen and protested against the introduction of the trolley in Brooklyn, * * * even some of the papers denounced me as an old fogy. These * * * insisted that it was safer than the horse car, and that wherever it had been tried it was found to be without fault and heartily approved by the people. These claims were, in the face of well-known facts, untrue, etc."

That is a misstatement, to say the least. The claim for the trolley was rapid transit, and proper degree of safety after people got a little used to the change. The majority of street car patrons wants to go quickly and the majority should have its way. That people do most heartily approve of the trolley is fully evidenced by their going out of their way to catch an electric car, rather than take a nearer horse car.

It is further evidenced by the numerous petitions of residents to the railway management in many cities to extend the trolley lines into new territory or along additional streets, so they may have like benefits of rapid service.

"The slender threads of wire that furnish the motive power are supplied with 2,000 volts of the death dealing current, and are liable to break at any moment and fall upon those who can avoid the flying car, but have no protection against the danger suspended above them."

A 10 year old school boy knows that the pressure is never over 500 volts, and generally less. A "veteran editor" should not have to resort to exaggeration to make his point. Yet he not only indulges in it, but he ignorantly implies that the trolley wire is like a water pipe under great pressure, and when it breaks it squirts a fatal stream of volts in all directions, and woe betide him who has no anti-electric garment. Stick to the truth, Mr. Veteran, and say that the pressure is less than 500 volts, and that instead of a "slender thread" the trolley wire is a heavy hard-drawn copper wire one-third of an inch thick with a breaking strength of almost a quarter of a ton.

"If a horse, crossing the track as the car goes by, steps with his forward feet on the rail alive with the electric fluid, and touches with his hind foot the rail on the other track, the current goes through him and he is electrocuted as suddenly as the victim of prison execution."

Considering that the current has lost all its pressure in propelling the car before it gets to the rail, that all four rails of a double track, or both rails of a single track, are connected directly together, and that the current is on its way back to the power house—nerveless and exhausted, as it were—the senescence of the aforesaid "veteran editor" is manifest. He evidently thinks the current goes out one rail and back on another, or that the "electric fluid" gets maddened by its whirl through the armature of the motor, and in angry revenge rises on its hind legs and smites its natural enemy, the poor horse.

"Those who ride habitually find that their fine watches will no longer tell the true time, and their bodies are subject to the reflective influence of the electric fluid."

This is really too rich for serious criticism. We venture to believe that the vaunted editorial pen of the "veteran editor" was nothing but a paste-pot and brush used in connection with indiscriminating scissors in collecting items about the "deadly trolley" from the columns of the daily press, which has to be sensational and furnish its readers with well spiced food, but all the same the collection so made is far from scientific truth and accuracy. It is saddening to reflect how a "veteran editor," bristling with accurate ideas on a vast range of subjects, can allow himself to be bamboozled into such absurd beliefs as are embodied in the quoted extracts above given.

Why will not such opponents of the trolley get down to the real facts and quit humbug? If people get hurt or killed, it is not the trolley that does it. A trolley car is simply a horse car with an electric motor under it, instead of a horse or two in front of it. The motor never hurts anyone. What is it, then, which does the damage? Simply rapid transit. The electric cars move more rapidly than horse cars. Accidents happen, and will happen, by people getting in the way until they become educated to the conditions. Proper life guards will do much to reduce the number of serious accidents, but the occurrence of the latter cannot act as a condemnation of the trolley system.

It was the same once in the case of steam railroads. People got in the way and got killed, and people get killed every day on these railroads now. But rapid transit for passengers, freights and mails is afforded, and the demand of the age is satisfied. It is but a question of the greatest good to the greatest number. A fast express train will carry the "veteran editor" to Chicago in 25 hours. Would he content himself with a way train keeping him on the journey for 48 hours? And if his fast express hurls the life out of some tramp loitering in the way, he might say, "Poor fellow! I'm sorry for him"; but would he venture to start a crusade against the monstrous cruelty of modern through trains?

No; rapid transit is a necessity of our own civilization, and we must have it at any cost. Electric motors are simply a convenient means to that end, and will be used until something still more convenient is perfected, and that does not seem likely. The accidents due to rapid transit on surface railroads would occur whatever the motive power. Horse cars run at the same rate of speed would be far worse, and it is absolutely true that the electric is much safer than the horse car under similar conditions of speed, and is infinitely preferred by a vast majority of people who ride.

A rather curious phenomenon in connection with the crossings of the Brooklyn City Railroad's cars at Fulton street, may be observed any evening. The great number of trolley wheels passing under the same wire gradually wear it so that continual sparking results. Very often a pretty fair sized arc is sprung which momentarily blinds whoever may, at that moment, be crossing the street. The effect is nearly always the same. The individual, on the lookout for the trolley cars on all sides, is bewildered, and the majority will pause for a moment, apparently annoyed, and then carefully looking in all directions makes a dash for the nearest opening and finally reaches the other side of the street.

# CORRESPONDENCE.

## OUR BOSTON LETTER.

**The Eastern Electric Cable Company**, of this city, have just declared their usual three per cent. semi-annual dividend on preferred stock, and sent checks to the fortunate holders of this gilt-edged article. Who said hard times? Mr. Henry A. Clark, treasurer of the company, knows nothing of them.

**Judge Colt's** decision in the case of the Edison Electric Light Company against Capt. A. de Khotinsky, was handed down on the 10th ult. The injunction asked by the Edison Company was granted, Judge Colt stating that according to the proofs submitted, the defendants' lamp contained, in his opinion, all the elements set forth in the second claim of the Edison patent. The present outcome of the suit was anticipated by all, Capt. de Khotinsky himself hardly looking for any other result, as for private reasons he was unable to submit to the Court the nature of the gases contained in his lamp, and consequently was in no position to disprove the affidavits of the Edison experts, who claimed that the vacuum found in his lamps was higher, if anything, than in those of the Edison type. Capt. de Khotinsky, however, is a man of resources, and will not be seriously affected by the fact of the decision going against him. He has been working for some time on an entirely new kind of lamp, which was fully described and illustrated in the REVIEW of December 20, and which he is now about ready to put on the market. Capt. de Khotinsky claims that this lamp is in every way superior to the old one, and that he contemplated substituting it for the former one in any event, and regardless of which way the decision was rendered. He is making every preparation for manufacturing in large quantities and will be heard from in the near future. H. G. T.

Boston, January 13.

## OUR WESTERN LETTER.

**Mr. Albert Scheible** will have the sympathy of his many friends in the loss of his father, whose death occurred early on Thursday.

**The Metropolitan Electric Company** has been occupying offices in the Monadnock building for some time past, but is now moving into its new building, 186 to 188 Fifth avenue, Chicago, where it will have ample facilities for carrying in stock the large line of staple goods which it is making a specialty of, suitable display rooms for samples and convenient counting rooms. Here Mr. W. H. McKinlock, Mr. Walter McKinlock and John J. Nate will be glad to meet their many friends.

**The Central Relief Committee** are already in receipt of returns from several of the electrical companies, the employés of which have made cash contributions of one day's earnings to the support of the unemployed. Among this number are the employés of the Central Electric Company, $51.50; Metropolitan Electric Company, $19.50; The E. B. Preston Company, $59.75; Chicago Gas and Electric Fixture Manufacturing Company, $143.85; *Electrical Industries*, $15, *Electrical Engineering*, $5. Nearly all the other companies have contributed funds, but the reports are not yet in the hands of the committee, and due notice will be given as soon as the same are announced.

**The World's Fair.**—The unfortunate and disastrous fire of last Monday has ruined the Court of Honor, and casino; peristyle and music hall are only a mass of blackened ruins. A small portion of Manufactures Hall was destroyed, and the French exhibits damaged to the extent of $50,000. Referring to the effect the fire will have on exhibitors, Collector Clark said that the buildings at Jackson Park will be emptied sooner than they would otherwise have been, for most of the foreign exhibitors are now anxious to get their goods out. Many who have left their goods and machinery in the building in the hope of selling them made inquiries at the Custom House to-day for warehouses outside the park to which they could move their property. F. DEL.

Chicago, January 13.

## General Electric News.

LIEUT. S. D. GREENE HAS NOT RESIGNED—RUMORS FLYING AROUND PRETTY LIVELY—REDUCTION OF THE FLOATING DEBT.

It was announced last week that Lieut. S. Dana Greene, assistant general manager of the General Electric Company, had tendered his resignation and would not go to Schenectady. When an ELECTRICAL REVIEW representative sought confirmation of the report last Saturday, Lieut. Greene replied with a nonchalant smile, "There is no truth whatever in the statement."

"Do you intend to go to Schenectady?"

"Yes," he replied, pointing to a confused mass of desks, books and papers. "You see they are moving us out now, and in a very short while I shall be safely installed in my new offices."

It is reported on good authority that after February 1 the services of assistant treasurer Arthur S. Beves will be dispensed with.

It is rumored that a foreign electric company is negotiating for the purchase of the factories of the General Electric Company at Lynn. Though nothing authentic can be learned from the officials of the company the intending purchaser is said to be the Siemens & Halske Electric Company.

Relative to the rumor that Harvard College had decided to sell its holdings of $250,000 General Electric five per cent. debenture bonds and 1,500 shares of preferred stock, Dr. H. P. Walcott, of the Harvard corporation, said to an Associated Press reporter that he was sure that the corporation had never invested in General Electric and held none in its assets.

The Boston *Globe*, on January 9, published these statements from its correspondent at Lynn, Mass.:

It is settled beyond doubt that technical director E. Wilbur Rice, Jr., will go to Schenectady, and private secretary John T. Broderick with him.

Prof. Elihu Thomson will not go unless he so wishes. He is not the servant of the company to the extent that he is obliged to remain at one or the other of its plants. He has an elegant home in Swampscott and is understood to prefer residence there.

The engineering department will go to Schenectady, and engineers Walter H. Knight, H. G. Reist, Frederick Fish, F. O. Blackwell and James B. Cahoon and their corps of assistants are preparing to leave Lynn.

To-day a number of subordinate officials, clerks and stenographers were notified that their service would not be needed after February 1.

It is not definitely known whether the drafting department will be removed.

The departments of manufacture which will remain at the Lynn plant are the arc lamp, meter, instrument, alternating current dynamo and small stationary motor departments.

These will be confined to factory C, and the other buildings of the plant locked up. The machines and tools in them, of which there are duplicate sets at the Schenectady works, will be allowed to remain, constituting a reserve or emergency plant.

About 600 hands will have employment in the factory C.

The river works will be left undisturbed to furnish castings for both the Schenectady and Lynn plants.

These statements all come from well-informed persons at the works.

Another news dispatch from Boston intimates that the annual report of the General Electric Company will show a reduction of the floating debt, including indorsed bills receivable, of from about $12,000,000 to about $1,000,000. By removal of the general offices from New York to Schenectady, $40,000 in taxes will be saved.

Concerning the published statement that an effort is being made to separate the Thomson-Houston Company from the General Electric, in support of which it was stated that a legal conference has been held in Boston looking to the legal possibility of a syndicate buying back the Thomson-Houston stock held by the General Electric and conducting the former company independently, President Charles A. Coffin is reported as saying, in an interview at Lynn, Mass., that there was not the slightest foundation therefor. It was an impossibility, so closely were the two interests amalgamated.

## Wall Street and the Electrical Stock Market.

In the electrical list, barring Western Union and General Electric, almost total stagnation prevailed last week. The public is not to any extent in the market. The professional element has no use for inactive securities. This is why the electrical list is neglected. The point made by me last week in effect that the radical liquidation which has taken place in General Electric will hurt the electrical security market for some time, was quite generally discussed among houses who make a specialty of this class of security. The consensus of opinion was that the effect could not be otherwise than detrimental, as capitalists are inclined to regard General Electric as typical of companies of its general class that are now fighting shy of all electrical securities in consequence.

Western Union was used as a lever to move the market. Its fluctuations for the week were confined within 83⅝ to 86⅛. The course of the stock was controlled purely by professional operators, being used by the bulls to start a general covering movement at least twice during the week. It has become a very easy stock to handle in this way, owing to the large absorption by investors. A moderate amount of short selling absorbs the floating stock in the street, which in turn establishes a premium. Any sharp drop brings out an investment demand, which almost invariably restores prices. Investors who have held the stock for years, receiving dividends thereon during that time, believe in it and are not easily shaken out by a few drops in the price. It closed to-day slightly weak at 84⅞.

There was, comparatively speaking, considerable activity in American Telegraph and Cable at 88 to 90. For the first time in months it has sold ahead of Western Union, by whom it is guaranteed 5%.

General Electric reflected in its course the rigid economies which are now being enforced, as well as the favorable decision in the "Novak" lamp case early in the week. On this decision the price advanced from 34¾ to 37⅛. It was subject to a bear raid on Thursday, which carried it down to 34⅜, from which it rallied, closing at near the highest figures.

Regarding this decision, Mr. Fish, counsel for the General Electric Company, informs me that an issue somewhat different from the one involved in the "Novak" case will be involved in the suit against the Westinghouse lamp. The "Novak" decision, however, has an important bearing on the question. No one has a right to speak with authority for the General Electric Company as to the extent to which it bears on the Westinghouse lamp. Mr. Fish expresses the opinion that the Westinghouse lamp has not yet become commercial, also that it infringes the Edison patent. He says the suit will not be brought until it does become commercial.

I am told that the annual report of the company will show a reduction in the floating debt, including endorsed bills receivable, of from about $12,000,000 to about $1,000,000.

The removals mentioned in another column last week have been going on all the week, and on the 15th, business will be done from Schenectady. By this line of policy the company will save $40,000 in taxes. It is said that most of the heads of departments formerly identified with the Thomson-Houston will resign, some of them to engage in private electrical enterprises.

At present between 2,500 and 3,000 men are employed between Lynn and Boston. When the changes are carried into effect there will be about 800 men employed at Lynn, and 1,500 men at Schenectady.

One of the strongest fields of General Electric at the present time is the supply business. It has been greater this year than in ordinary years, owing to the policy of lighting and power plants all over the country to utilize apparatus on hand. It is said that it will amount to $4,000,000 for the year, and although in a prosperous year it may drop off from that figure the difference will be more than made up by new business. The preferred stock sold in Boston during the week at 56 and 58.

There is no doubt in my mind but what the radical economic policy which has been enforced in the affairs of the General Electric company, has placed it upon a solid profit earning basis. This is sure in time to inspire confidence in the stock, which will extend to other electrical securities. Drexel Morgan & Company are said to be largely responsible for these changes.

The fact that the company has been able to stand the great financial strain and pruning in all quarters is a testimonial to its inherent vitality. The one great weak feature which remains is its immense capitalization. There is no doubt but what the company from now on will do a paying business. However, the question of earning a dividend on an enormous capital stock, a good portion of which is water, is another matter. It will appear that Wall street has grasped the situation and reduced the prices of these securities to an intrinsic basis.

The debenture 5 per cent. bonds, which are regularly paying their interest, sold during the week at 71½ to 73.

There were no sales of the Edison Electric Illuminating of New York or Brooklyn. There were a few transactions in the 5 per cent. bonds of the New York Company at 103½.

On the Boston Exchange Bell Telephone showed considerable strength, rallying from 186 to 190, and closing Friday at 188½. Erie Telephone was steady at 43½ to 44. New England Telephone sold at 54. Fort Wayne Electric was bid 3½ and asked 4½. This is an increase of about 1 per cent. in the asking price. Westinghouse Electric first preferred was bid 46 and held at 47.

New York, January 13.

## Stay of Injunction Granted in the "Novak" Case.

Judge Shipman handed down his opinion (p. 28) over a week ago in favor of the Edison Company, and press reports were immediately sent out stating than an injunction had been granted against the Waring Company. The reports, however, were rather premature, as Judge Shipman would allow no papers to be served, and personally notified the Waring Company to continue manufacturing pending a further hearing of counsel, which was held on January 13, at Hartford.

The judge's original opinion was the subject of considerable criticism, and notice of an appeal was at once filed by counsel for the Waring Company. When the case was again called on Saturday last, the court announced from the bench that there was considerable doubt in his mind as to whether his opinion would be confirmed by the Court of Appeals. There were a number of new features in the case and several delicate questions to be considered, as to the merits of which he was not sufficiently positive to warrant him in granting an injunction, and consequently he refused to do so. He therefore waived the matter subject to the decision of the Court of Appeals, and allowed the Waring Company to continue the manufacture and sale of their lamps under $10,000 bonds.

This decision was not at all satisfactory to the plaintiffs, and met with a vigorous protest from Mr. Fish, who offered to furnish bonds himself if the injunction was granted, and the works closed down.

His protest was without avail however, and arrangements were immediately made by the officers of the Waring Company to furnish the necessary bonds.

Mr. A. D. Claflin, of the firm of Claflin & Kimball, of Boston, selling agents for the "Novak" lamps, stated to an ELECTRICAL REVIEW representative that he was very confident as to the ultimate outcome of the suit, that his company was prepared to fill all orders as heretofore, and that users of the lamp were fully protected. The Court of Appeals opens a three weeks' session on January 23. The case will be argued during this sitting, and a decision will be rendered probably within the next two months.

On Thursday, January 4th, Mr. J. V. Z. Anthony, the young and enterprising manager of the Middletown, N. Y., Electric Light and Power Company, was quietly married to Miss Frances James, of Jersey City Heights. Miss James is conceded to be the belle of the section wherein she resides. The young people have our wishes for many years of happiness.

### An Electrically Operated Street Railway Switch.

The street railway switch illustrated herewith is designed principally for application to electric cars, although it admits of being applied to cars propelled by other power. It has been patented by Mr. Henry L. Falco, of Brooklyn, N. Y. The view in perspective shows the operation of the improved switch, Fig. 1 being a longitudinal and Fig. 2 a transverse section, while Fig. 3 shows the contact making device. The car may be supplied with the electrical current through a trolley, by storage batteries, or by a small dynamo taking power from the car axle, the wire carrying such current leading to the contact maker just under the car platform, and carrying at its upper end a foot piece to be pressed upon by the driver or motor man. The contact maker adapts itself to any distance between the car and the contact plates. The switch tongue turns on a pivot, and is mounted in a casting in the usual way. A pin projects from the tongue through a slot in the casting, and enters an arm on a sliding rod in the switch pit, there being on opposite ends of the rod cross-bars carrying armatures which enter the coils of electro-magnets. These magnets have short cores and are inclosed in lead to prevent their being acted on by water entering the pit, and the mechanism is inclosed in an iron box with cross-bars through which the rod slides, there being on the rod buffers to prevent shock when the armatures are drawn in either direction. There are two insulated contact plates in the road bed near the track rail, a wire from one plate extending to one of the magnets, while the other plate is connected by a wire with the other magnet. When, therefore, a car approaches the switch, the driver can swing the switch tongue in either direction, to open or close the switch to the main or the side track, by simply pressing on the foot-piece to bring the roller on the lower end of the contact maker down upon one of the contact plates in the road bed, the current then being made to energize one or the other of the magnets to move the sliding rod connected with the switch tongue. The box containing the magnets is closed at the top by serrated covers in the usual way.

### The Formenephone.

The formenephone, quite recently invented by Mr. M. E. Hardy, is an apparatus designed to trace in air the presence of any gas having a different density. His fundamental idea is as follows: It is a well-known acoustical principle that if two organ pipes of the same pitch are sounded simultaneously by means of blowers, fed by pure air, we hear a simple sound; but if we force through one of these pipes pure air, while the other is thrown into vibrations by means of a mixture of air and gas, the sound of the latter pipe is correspondingly modified; consequently when the two pipes are sounded simultaneously, a certain number of interference beats will be heard, depending upon the quantity of gas contained in the air with which the pipe is fed.

The formenephone, the apparatus by means of which this experiment may be made, consists of two blowers and two organ pipes exactly alike. One of the blowers and its appropriate pipe is enclosed in an air-tight box containing pure air. The other pipe is fed by a mixture of air and gas. Each experiment takes but a short time, lasting perhaps a few seconds.

The formenephone is directly applicable to the detection of the quantity of coal gas in coal mines, and may be so constructed as to give continuous indications not only in the mine, but also in the chief engineer's office.

If used for this purpose, a microphone with a receiving telephone is placed upon each organ pipe. When the two pipes are in unison, the sound is clearly reproduced by the telephone, likewise any interference beats that may occur.

To avoid the trouble of holding the telephone constantly to the ear, M. Hardy substitutes for it an amplifying microphone, consisting of an electro-magnet mounted upon the poles of a permanent magnet. A vibrating steel spring carries upon its free extremity a conical piece of carbon. Another light, insulated spring carries a flat disk of carbon which lies upon the conical piece of carbon. The current of a local battery traverses the two carbons, and then passes through a large receiving telephone fastened to the wall of the room. Thus the receiving telephone repeats the sounds of the microphone amplifying the latter about 400 times, and any beats are easily heard throughout a large room.

### Mr. John J. Nate.

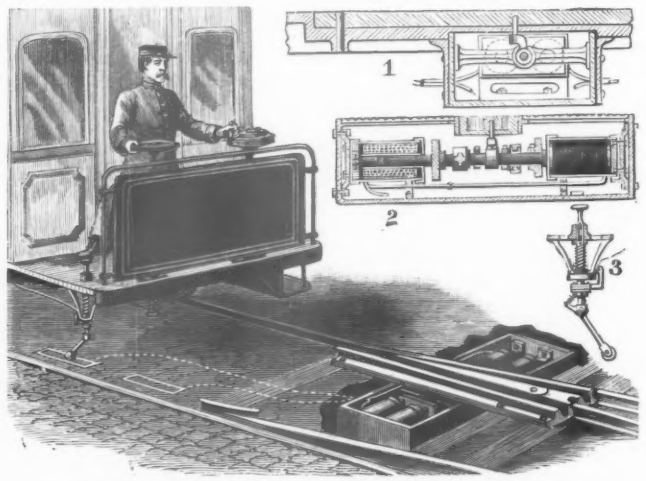
The Metropolitan Electric Company, of Chicago, have added to their official staff Mr. John J. Nate, for many years purchasing and supply agent for the Chicago Telephone Company, and are to be congratulated in having secured the services of a gentleman so well and favorably known in electrical circles.

Mr. Nate's connection with the telephone business dates back to the Summer of 1878, when H. H. Eldred, general agent for the American Bell Telephone Company, opened

MR. JOHN J. NATE, MANAGER METROPOLITAN ELECTRIC COMPANY, CHICAGO.

at 125 La Salle street the first telephone office in Chicago. Shortly thereafter the Bell Telephone Company was organized; following this organization came the Union Telephone Company with C. N. Fay as general manager, absorbing also the telephone and messenger business of the American District Telegraph Company. During these changes Mr. Nate's experiences were varied and thoroughly practical, and his advance rapid, while his work as foreman, exchange manager and superintendent of equipment would furnish historical reading matter of no small interest. About 10 years ago the Chicago Telephone Company succeeded to the business of the Union Telephone Company, and a few months after this re-organization Mr. Nate was appointed purchasing and supply agent, in which capacity he remained until January 1, 1894, when a favorable offer from the Metropolitan Electric Company secured his services.

In view of the demand which will undoubtedly arise for experienced men in the work of handling the on-coming telephone business, the Metropolitan Electric Company are to be congratulated in having secured thus early in the day the services of a man so thoroughly well fitted by long experience and wide acquaintance as its manager. The telephone business has lost a valued representative, but we believe in the broader field of commercial enterprise Mr. Nate will meet with success, and the ELECTRICAL REVIEW joins with a host of others in congratulations and well wishes for his prosperity.




AN ELECTRICALLY OPERATED STREET RAILWAY SWITCH.

### The Practicability of Electric Conduit Railways.

READ BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, NEW YORK, DECEMBER 20, 1893, BY ALBERT STETSON.

Two years ago if an electrical engineer had been asked as to the practicability of an electric conduit railway he would probably have shrugged his shoulders and expressed great skepticism as to ultimate success. The writer hopes to be able to show that some real progress has been made since then, and that the way out of the difficulty is in sight.

Electric traction for street railways has come to stay, and we must choose between the trolley, secondary battery and a conduit construction (either slotted or closed). The trolley has been, and still is, the most important factor in electric traction. It has done, and still is doing, excellent work in educating the public into the beauties of rapid transit in cities. There is much talk in our sensational daily press about the "deadly trolley," but much of it is ridiculous, and most of it undeserved. Surely, no member of this Institute has joined in this outcry, and it would be a move in the right direction if some of our daily papers would have attached to their staffs men who are capable of judging of technical subjects, so that they might be able to impart correct ideas as to the march of human ingenuity and progress. Our daily newspapers have specialists to report society scandals, dog fights, pugilism and horse racing. But, is it not strange that none of them employs trained technical experts? The progress of the arts and sciences is certainly as interesting to the average man and woman, as is what ladies do and say in a Turkish bath. It is, perhaps, useless to undertake to reform the press in this respect, but until we can, we must expect from time to time to hear of the "deadly trolley." There is a field and a wide one for the trolley, and the men who have devoted their talents and their money to advancing electric traction by the trolley deserve well of the race. Many men have worked in this field, but I believe that Mr. Frank Sprague, with his 12 miles of road in Richmond, working successfully, sent electric railways forward 20 years. All honor then to the trolley men. They have and will hold for a long time the field in smaller cities and towns, and for inter-town communication. Railroad men, as a rule, are very conservative, and until a few months ago there was nothing in sight that gave promise of our being able to do away with the trolley in cities. Certainly they could not be expected to wait until something practical appeared, nor could they afford to stop their cars as soon as they heard of fairly successful experiments with a conduit railroad. Large vested interests cannot be overthrown nor changed in a moment, and it will be interesting to see what position trolley men will take when the conduit has demonstrated its utility and practicability. I expect to find them more than ready to adopt it wherever the traffic will warrant them in so doing.

We have admitted the claims of the trolley people and given them due credit. But there are also rights of the public that must be respected. The streets of our cities belong to the public and not to corporations. So long as nothing better was in sight, it was to the advantage of the public to have rapid transit, even though the trolley were the medium. But the structure is unsightly, and the poles and wires are a constant menace to the public. A trolley current will not, probably, kill a man who has no organic disease, but it will kill an animal. It will terribly burn anyone who comes in contact with it, and would probably cause the death of a man troubled with heart disease. The feed wires are a constant source of danger. A trolley wire may get crossed with an electric light wire carrying an arc current, and it then becomes a dangerous thing. If the streets are at all wide, very large poles, taking up too much sidewalk space, are used, and these invade public rights. We have a right to beautiful streets, and no corporation, for the sake of private gain, has a right to disfigure them. We have a right to safe streets, and no corporation has a right to contribute anything towards rendering them less safe. In our cities and large towns, trolley as well as other current conveying wires must go underground so soon as any economical and practicable method is demonstrated.

Secondary batteries have been used in nearly every large city of the civilized world, to supply the demands for electric traction, but have been given up as too costly. I know there are still people who are willing to spend their money on this *ignis fatuus*, but the number is growing beautifully less year by year. The writer has spent more time in investigating the subject here and abroad, has examined everything in this line that Europe has offered, and he asserts, without fear of successful contradiction, that not one instance can be found in the world where a traction secondary battery has paid an honest dividend. The cars (if supplied with sufficient power) are too heavy for ordinary track construction, the heaviest ballasted steam track being scarcely good enough to insure them a commercial life. The conditions essential to the life of a secondary battery are large, thick and heavy plates. Such a battery can probably be commercially employed in lighting stations, but those are diametrically opposed to the conditions for a traction battery. In traction, the battery must be small (on account of the limited space at our disposal), and it must be light; for every 150 pounds of lead carried means the cost of transporting a passenger. To run sucessfully, we must be able to ascend such grades as exist in railway work, and when sufficient battery power for this is carried, the car becomes unwieldy. A sudden call for power from a small battery may tear it all to pieces, and the "self-contained" car then becomes anything but an "ideal" motive power. When, in 1881, Sir Wm. Thomson carried across the channel, Faure's little box containing 1,200,000 foot pounds of electrical energy, great hopes were excited, and those million foot pounds of energy were soon changed into millions of shares, and that changing process has been going on ever since. The average investor did not, of course, know that those large figures represented about the energy of one and one-half ounces of coal, and that, if Sir William had brought his pockets full of good cannel coal, the supply of energy in Old England would have been much increased, but investors did believe that there was the "ideal" system for electric traction. The best electrical, chemical, mechanical and engineering skill was employed, improvements were made on the original cell, millions upon millions of dollars were spent, and the results have been financially disastrous. Remember, please, that, to any but the electrical crank, the treasurer's books are the court of last appeal. The experience has been costly, and the shores of Old England are strewn with the wreckage of secondary battery ventures, and the bones of many a victim lie bleaching in the sun! But has nothing been done since then that gives promise of better things? Judged by my standard (the dividends paid), I answer, "No!" and to one who understands the principles involved in a successful traction battery, there seems to be nothing in sight to bid us hope for a successful solution of the difficulty from this direction. Should future metallurgists make us acquainted with some new metals, or should a cheap supply of palladium become available, the problem may be changed. But the writer believes the experiments of the E. P. S. Company in England, and those of the Julien Company in this country, exhausted the possibilities under commercial conditions, and that we have seen no better battery than theirs. It is often said that the patent complications stopped the secondary battery experiments in this country (they did not in Europe), but I am unable to understand how. The Brush Company has the patent rights, and the Julien Company, or its successors, the exclusive license, and I have not heard of any extraordinary exertions on the part of the Brush Company to reduce their surplus by secondary battery experiments—and I do know that the cars used in the Julien Company's Fourth avenue trials are for sale at "genuine bargain" prices. I admit that I may be mistaken, but universal experience is a pretty safe guide, and anyone trying to work out a system of accumulator traction has my sympathy, and my prayers that he may early see the error of his way and return to the fold before the last fatted calf has been killed and eaten.

In a paper read before the American Street Railway Association, at Pittsburgh, on October 21, 1891, Mr. George W. Mansfield said:

"Our rival is the cable. It certainly does

look as if for the enormous sums they expend in making their system feasible, we ought, for an equal sum, to make ours perfect. Mechanically it is an assured success, but electrically it has not so proved."

In large cities, the cable is a real rival of electric traction, and in many places has proved commercially successful. But there are some things that may give the electrician hope. The cable roads of St. Louis have, to a very great extent, given up their cable and are using the trolley, while those of Kansas City and Denver are said to be in a bad condition financially. City railroads in the future will, no doubt, be electric, and it is questionable whether any more cable roads will be built. The cost of the powerful machinery required, the wear and tear upon the cable and the grip, the large amount of real estate required for their buildings, constitute serious "first charges" upon the earnings of cable companies, and confine their operations to very large cities where traffic is enormous. Electric traction demands only a portion of the expense necessary for a cable road, and capital is seeking this method for investment, while "fighting shy" of cable roads. When a car is on the track, ready to be moved, it is a question of veracity between the electrician and the cable man as to which motive power can move it more economically. Perhaps the advantage lies a little in favor of the cable man, but when interest on capital invested in buildings, real estate, machinery and the natural deterioration are taken into account, the electrician appears to have much the better of the argument. It is, of course, true that the cable traction has greatly increased the revenue of the Broadway line, but so would electricity have done. It is a well-known fact that the better the facilities offered for travel, the more people will avail themselves of them, to the increased profit of the company supplying the need. There is nothing in the cable success here in New York to discourage the electrician, and I hope to see in a few years a conduit system in operation on Broadway and Third avenue.

There is one other class that may be mentioned in passing, where mechanical motors are employed on the separate cars. Many different motors have been proposed, such as carbonic acid gas, ammonia, gas engines, hydraulic motors and compressed air. None of these have, to my knowledge, demonstrated their commercial utility, though I think the future outlook in this direction is promising. Some years ago, in company with Mr. Stauffer, of this city, I rode over the road from Vincennes to Paris, on a line operated by the McClosky compressed air system. Its operation was all that could be desired from a spectator's standpoint, but I mistrust it had the same trouble as many

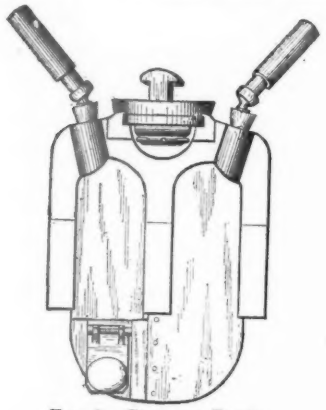


FIG. 2.—CONTACT PLOW.

others; good enough to spend money on for experiments, but unprofitable from a financial point of view.

We now come to a consideration of conduit roads, their excellencies and their defects.

For years electricians have worked to develop a practicable conduit system of electric railway, and many attempts have come near to success. The most extensive and, until recently, the most successful, was the Bentley-Knight system. An immense amount of money was spent, the best talent was employed, and extensive lines were built at Cleveland and Allegheny City. Experiments were made in New York and Boston, and with the withdrawal from the field of the Bentley-Knight system disappeared the last hope of our being able to place bare wires in a slotted conduit exposed to the severe conditions of our American climate. There is not a city in America to-day where a bare conductor laid in a conduit can earn a dividend on the capital invested. No matter what the system may be, no matter how carefully the insulators may be protected, unless the conduit is made air-tight and water-tight (which, of course, no slotted conduit can be), mud and dirt will get into the conduit and settle on the conductors. Leakage takes place from a conductor in proportion to the length exposed, and glass, porcelain, ebonite or any other of the so-called insulators, when covered with dirt, conduct the current as well as a similar layer of dirt elsewhere would do. Over the path in this direction Nature seems to have posted the warning, "No thoroughfare!"

Mr. F. L. Pope, in an article quoted by Carl Hering,* says, in speaking of conduit experiments: "Hundreds of patents have been taken out and more than a million dollars have been disbursed in paying for tuition in the costly school of experience. More than once, and in more than one direction, success has at times seemed almost certain; yet the truth compels me to say that from the hard practical standpoint of dollars and cents, by which every invention must first or last be tried, the net outcome of all

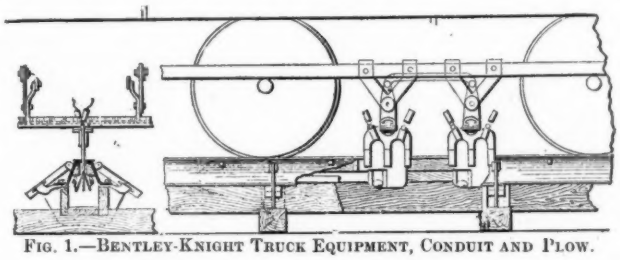


FIG. 1.—BENTLEY-KNIGHT TRUCK EQUIPMENT, CONDUIT AND PLOW.

this vast expenditure of labor, time and money has, up to the present moment, been almost insignificant. The reward which awaits the fortunate person who succeeds in completely solving this problem may well be regarded as a potentiality of wealth beyond the dreams of avarice. The problem of the underground circuit does not at first sight appear to be a very difficult one. It renders necessary, in the first place, a construction which will effectually resist the action of forces tending to disturb the condition of the wires, and with the heavy traffic on the streets this involves a very strong structure. It is absolutely necessary that the conductors shall remain insulated from each other and from the ground under all conditions of weather. The exigencies of heavy rains and snows necessitate a construction which shall permit of a thorough insulation of the conductors and a drainage of the entire system. There are other minor points which require to be taken into consideration. Without going into details, it is sufficient to say that the conduit system has been tried on an extensive scale in Denver, Cleveland and Boston, and to a lesser extent in several other places, but in every case the continual interference, consequent upon its use, has exhausted the patience of the traveling public and compelled its abandonment."

Mr. Mansfield, in the paper quoted above (also Hering, page 170), says:

"In spite, however, of all this refinement and study, practically nothing has been accomplished; and I have no hesitation in saying that the continuous live conductor in an open slotted conduit is to-day a failure, and that it cannot be made a success throughout our cities of to-day, its fatal weakness being our inability to prevent the conduit from becoming filled with water, mud, etc. The time may come when our sewerage systems will be perfect enough to enable us to overcome this fatal weakness. To-day, however, they are not, and even an optimistic view puts this time a long way distant."

Mr. F. H. Monks, of Boston, says: "The conduit system has been thoroughly tested, and has been shown to possess no commercial value for the propulsion of street cars to date." The standard work, "The Electric Railway in Theory and Practice," by Oscar T. Crosby and Louis Bell, Ph. D., says, page 255:

* * * * *

"The fundamental difficulty with all slotted conduit electric roads is the enormous difficulty of proper insulation. This arises from the very nature of the case, for the conductors are placed in a tube of limited diameter in free communication with the open air through the slot. Water, dirt and mud inevitably find their way in, and sooner or later the result has been either a positive short circuit at a single point, or general leakage along the line in sufficient quantity to paralyze its operation."

### THE BENTLEY-KNIGHT SYSTEM.

We have already referred to this ill-fated method. They failed, but they made a noble fight. They had talent, experience and money, and they did thoroughly demonstrate that a conduit road using a bare wire cannot operate commercially in our American cities. I do not say that it is impossible to find men who will still put their money into such systems, nor do I maintain that men cannot be found to spend shareholders' money in such experiments, but parties working in that direction can well learn from the sad experience of the investors in the Bentley-Knight road. The laws of electricity have not changed since then; no great improvements have been made in insulating bare conductors; and, although I have examined a number of conduits with bare conductors, none of them have shown better construction, such expert technical skill, such regard for the laws of electricity, and none came nearer success. It is the same old story, too great expense and the impossibility of insulation.

In this system there is a conduit between the rails, provided with a slot, through which passes a brush for making contact with the bare wires laid in the conduit. They use a constant potential, about 500 volts being the normal voltage. The current strength is about 7.5 amperes, and the motor used will stand 60 amperes for half-an-hour. The electrical equipment is mounted on the truck, entirely independent of the car body, and the car is started and controlled precisely as the trolley car is. The illustration shows the essential features of their construction, and at the left is shown a diagram of the conduit and the "plow." The "contact plow" is shown in the next illustration. "It consists of a flat frame hung from the car by transverse guides, on which it is free to slide the whole width of the car, and extending thence down through the slot of the conduit. It is provided with a swivel joint, so as to adjust itself to all inequalities of road or conduit. The frame carries two flat insulated conductor cores, to the lower ends of which are attached, by a spring hinge, small contact shoes of chilled cast-iron that slide along in contact with the two main conductors. At the upper ends are attached flexible connections to prevent flashing at the contact." This road was worked in the Winter time, during the season of 1884–5.

The insulating support is "of vitreous material having supporting pins sealed in it for connecting it to the conductor and to the wall of the conduit inclosing the conductor, and having a flange at its base for protecting the conductor from the moisture that may accumulate upon it or the walls of the conduit. To prevent the water coming in through the slot from causing a leak from the conductor to the metallic conduit, the insulator is provided with a water-shed flange at its base, which is preferably curved outward on the form of a saucer, though any suitably-shaped flange may be employed, and the insulator extends out horizontally from the conduit, so that the flange occupies an upright position." This is taken from United States Patent No. 455,339, of July 7, 1891, to Walter H. Knight, and further on in the same patent Mr. Knight sounds the key-note of the entire situation, and shows the rock upon which he and others using the same system have wrecked their barks. He says: "It has been found that upon the insulators there is apt to be an excessive condensation of moisture, owing to the fact that the conduit is beneath the surface of the street, and that at certain times an excessive leakage is apt to occur at certain ones of the insulators," and he goes on to say: "This leakage has a tendency to correct itself, that is, the heat engendered by the passage of the leaking current dries up the moisture which has given rise to it."

True, but that is rather an expensive drying process. Electric energy costs money to produce, and it loses as its distance from the prime motor increases, and then to use it for keeping the streets of cities dry (for it really amounts to that) is hard on the coal pile and the anticipated dividends. The Bentley-Knight conduit system was the harbinger of better things. Splendidly constructed and well managed, but working on the wrong principle, it stands to the commercially practicable conduit road of the present and the future in about the relation of the telephone of Philip Reis to the finished product of Professor Bell's genius.

Of the Love system, now working in Washington, I have not been able to get any accurate or reliable information, and I have heard no favorable reports thereon from impartial authorities. Their conduit is well built, their road is level, and their wires are protected in the same manner as failed to protect the Bentley-Knight conductors. The details do not appear to have been worked out so completely as they were in the Bentley-Knight system. About Thanksgiving of last year I was in Chicago, and took occasion to visit and inspect the Love railway. It was not running at the time, had not been, I was informed, for a couple of months, and it was exceedingly doubtful when it would start again. I saw a plain, level piece of track, one half to three-quarters of a mile in length, over which two cars were to be run, and at the power house a generator of 125 horse-power. Now, gentlemen, that is not practical electrical engineering. There is the same bare wire in the conduit, and, until the laws of Nature are changed, there must be the same difficulties that have frustrated other attempts in the same direction. Of the Chicago conduit road Crosby and Bell say, page 256: "The general character does not insure immunity from the difficulties that have caused the abandonment of similar attempts in the past."

### THE BUDA-PESTH ROAD.

At Buda-Pesth, in Hungary, is the only conduit road employing a bare conductor that has ever achieved measurable commercial success. The best description I have been able to obtain is found in the book of Mr. Hering: "Recent Progress in Electric Railways," pages 175 *et seq.*:

"The conduit, as seen in Fig. 25 (see illustration), is placed under one rail. It consists of castings having flanges of 18 centimetres (7 inches), placed every 1.2 metres (about 4 feet), the space between being a conduit of concrete. The oval shaped conduit has a width, clear, of 28 centimetres (11 inches), and a height of 33 centimetres (13 inches).

"The slot consists of two beam rails having no inside lower flange, and fastened to the conduit frames by wrought-iron angle pieces. The width of the slot is 33 millimetres ($1\frac{5}{16}$ inches), the total depth of the foundation below the rail top is 70 centimetres ($27\frac{1}{2}$ inches). The conductors, both positive and negative, are made of angle irons, secured, as seen in the figure, by means of insulators fastened to the castings. They are sufficiently high above the floor of the conduit to be protected from the water which may collect in the conduits. They are, furthermore, under the top of the oval, so that they cannot be touched from the outside. It should be noticed that there is no earth return used with this system, as both leads are insulated. The water which runs into the conduits is collected at the lowest points, and passes through settling boxes to the sewers. The second track may be of any desirable form, even only a flat rail. An objection to having the conduit under one rail instead of in the middle arises in cases where, by the nature of the course of of the track and the curves, the cars become reversed in their positions on the track; such cases can probably be avoided by proper laying out of the road, and in the worst case by a second conduit under the outer rail for parts where it cannot be avoided. On a one-

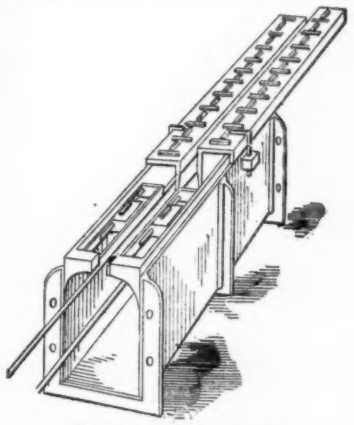


FIG. 3.—LOVE CONDUIT.

track line the cars must have their front and back platforms alike, as they cannot be turned around.

"The car truck and the motor are the same as those used in connection with their overhead system;" * * * "Only one axle is driven; the other is flexibly connected to the third point of support of the motor frame. The starting, stopping and reversing of the motor is done as usual by a crank at either end of the car operating the same switches. Controlling resistances are placed under the body of the car.

"* * * In a public address, one of the engineers of the company stated that the latest figures (July and August, 1891), of the cost of running, were only 37 per cent. of the income, which certainly is remarkably low." * * *

*(To be continued.)*

* Recent Progress in Electric Railways, pp. 168–170.

## Electricity and Windmills.

The Netherlands Society for the Promotion of Industry, whose seat of operations is at Haarlem, Holland, is offering a prize of $150 and a gold medal for the best paper submitted on the production of electricity by windmills—its storage, transmission and utilization. All papers must be sent in before July 1, 1894, and all particulars may be obtained from Mr. F. W. Van Elden, the secretary.

## Official Report on the Tests of Electric Power on the Erie Canal.

CITY ELECTRICIAN BARNES, OF ROCHESTER, FAVORABLY DISPOSED TOWARD THE SCHEME—DETAILS OF HIS REPORT.

Edward Hannan, Superintendent of the Public Works of New York State, has transmitted to the legislature his annual report for the year ending September 30, 1893, on the trade and tonnage of the canals for the year. Incorporated in this report is an official record of the tests of electric power recently made on the Erie Canal near Rochester. The report is signed by Mr. C. R Barnes, the City Electrician of Rochester, who was engaged as an electrical expert by Superintendent Hannan and State Engineer Schenk. The report follows in full:

OFFICE OF THE CITY ELECTRICIAN,
ROCHESTER, N. Y., December 11, 1893.

*Hon. Edward Hannan, Superintendent of Public Works, Albany, N. Y.:*

DEAR SIR—In accordance with your instructions, I have made a careful and thorough examination of the subject of propelling the ordinary boats on the Erie Canal by electricity obtained from a trolley system as motive power, and the following facts and conclusions derived from the limited data thus far available are herewith submitted:

As no application of an electric trolley system to boats of any description had ever been made, it became necessary to ascertain the adaptability of the system by actual trials with a full-sized boat on the canal itself, and the requisite experiments were made November 18, 1893, on a section of the Erie canal in the town of Brighton, adjacent to Rochester, N. Y., by the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., with the canal boat "Frank W. Hawley," in pursuance of the provisions of an act of the legislature of 1892-93. The boat referred to was 98 feet long, and had been equipped with a steam boiler, engine and single screw propeller, the latter being of a pattern known as the "dish-pan propeller," having a disk of 51½ inches in diameter, to which four screw blades were attached.

To operate this boat by electricity the Westinghouse Electric and Manufacturing Company placed over the canal two trolley wires, which were suspended from cross wires attached to poles on each bank, for a distance of about one mile around a sharp curve and through lock No. 64. One of these wires was connected to a trolley wire of a recent extension, on line of railway belonging to the Rochester Railway Company, while the other served to return the current, and was connected to the rails of said extension. The steam boiler and engine were removed from the boat, and were replaced by two 25 horse-power Westinghouse single-reduction motors, placed in the stern and connected directly to the shaft of said screw propeller. Two ordinary street car trolley equipments were placed on the middle cabin of the boat, one of them connecting with the positive trolley wire above, and carrying the current to the motors below, in the same manner as a current is taken to a street car motor, while the other connected with the negative or return wire, and returned the current by an overhead wire instead of underground. The starting and stopping was done by means of one of the Westinghouse controllers, such as are used on street cars. The boat was, furthermore, loaded with a large quantity of sand, and during the trial carried on board about 300 people. The quantity, intensity and energy of the electric current, which was expended during a run of 2,800 feet, between locks Nos. 63 and 64, in both an easterly and westerly direction, together with the average rate of speed attained, are given in tables Nos. 1 and 2, hereto appended. As will be seen, the electrical measurements were made at very frequent intervals and with the most approved instruments. The latter consisted of a Weston voltmeter and ammeter, together with a Thomson recording wattmeter, which served to check the results obtained from the two former. From the tables it will be seen that an average of 24.87 electrical horse-power was required to propel the boat at the rate of 2.65 miles per hour, against both the current in the canal and a strong head wind, while 26.21 electrical horse power was required to attain a speed of 4.24 miles per hour in the opposite direction. It should, however, be remarked that the machinery was not in proper condition nor well adapted to the purpose, inasmuch as it required 5.35 electrical horse-power to revolve the wheel at the same rate of speed out of water as it did while making the test in the canal. This was ascertained by placing the boat in a dry dock and operating the propeller in the air alone. It will thus be seen that the losses by friction in the machinery and by inefficiency of the motors amounted to more than 20 per cent. of the whole power, since a certain addition to the above loss must be made when the boat is propelled in water, on account of the friction due to the thrust of the propeller, which was absent in the dry dock test. Under more favorable conditions of machinery and apparatus, it is reasonable to anticipate that a considerably smaller loss by friction and inefficiency of motors would have been observed, and hence, also, that the gross energy consumed in propelling the boat would have been proportionately smaller.

The low voltage shown in the appended tables is partly explained by the fact that in the motors may fairly be ascribed to the fact that they were operated with a current of only about 300 volts on the average during the test, whereas they were designed to be operated with a current of 500 volts. Taking all these circumstances into account, it may be estimated that with a stronger current and better machinery the same speeds would have been reached with an expenditure of not more than 21 electrical horse power.

To attain more favorable results and to better adapt the system to practical service, I may mention that the trolleys should be constructed so as to allow the boat to occupy any position in the canal and still receive current, and that the wires be so arranged that one boat can pass another, going in the same or opposite directions; and that the motors shall be especially adapted to the purpose and be designed so as to occupy the smallest possible space with the least practicable weight, so as to leave the greatest possible amount of storage room available in the boat. It is also a question whether some modification of the lines of the boat and the use of twin screw propellers of greater efficiency would not prove advantageous.

In regard to the cost of electrical propulsion, but little definite knowledge can be deduced from these experiments. The essential element in the case is the cost of establishing and maintaining the necessary power along the line of the canal, and this will necessarily vary at different places and with different methods of production. Where water-power is available and can be cheaply developed, the cost of power will obviously be much less than where it must be produced by steam engines. In order, however, to reach some definite figure, I have made an approximate and very conservative estimate of the cost of equipping and operating a steam and electrical plant capable of supplying with necessary power at least 200 canal boats distributed over a length of 50 miles of canal. Assuming that this plant is in operation not more than 210 days per year, which is the ordinary limit of the season of navigation, my computations show that the cost will be somewhat less than ten cents per mile per boat, and if the power-generating machinery can be used profitably during the remainder of the year in supplying power to manufacturing establishments in the vicinity of the station, the cost of the canal propulsion will be correspondingly reduced.

It should be remarked that this computation refers to a speed of three and one-half miles per hour for the boats, and that two boats are coupled together. Furthermore, if four or six boats are coupled together, an appreciable reduction in power per boat is effected, as has been demonstrated from trials with steam canal boats, and hence a similar reduction in the cost of electrical propulsion would ensue by adopting such a plan of navigation. It must also be remembered that, while the foregoing estimate is based upon the delivery of a current of limited voltage produced by steam power, the promoters of the electrical system of propulsion, on the other hand, expect to obtain the necessary power at very low rates from turbines at Niagara Falls, and to use a current of much higher voltage with a variety of new methods of transmission and transformation, whereby a great reduction in cost of delivery to motors in canal boats is anticipated. From well-known and competent electrical authorities I am assured that by the contemplated methods of obtaining and delivering the power the cost of propelling boats by electricity will not exceed five cents per boat per mile. It will, therefore, be seen that the claims to consideration of electricity as a motive power on the canal are extremely well founded, and that its development is worthy of the utmost encouragement.

From the most reliable statements of the cost of steam propulsion on the Erie Canal it will be found that, even with my conservative estimate, electricity may already be considered a fair competitor of steam, with the great advantage that the relatively large space occupied by the steam boiler and engine in the boat is saved for freight, that the danger from fire or explosion is avoided, and that the management of the boats and their propelling is greatly simplified.

The experiments above described were of great interest to the friends of the canal system throughout the State, and were graced by the presence of Governor Flower, the officers of the canal department and other State officials, as well as by a large assemblage of distinguished public men, electricians and engineers from many localities. They have also attracted a vast amount of attention from advocates of inland navigation projects, both in the United States and in Europe, and it is to be hoped that they will be continued on a more elaborate and satisfactory scale next year, whereby more reliable data will be obtained.

In conclusion, I beg to acknowledge my indebtedness to Messrs. Alfred Green, Chas. F. Burns and George A. Redman, electricians of this city, for kind assistance rendered by them in taking readings of the various electrical instruments used in making the tests.

Respectfully submitted,
(*Signed*) C. R. BARNES.

TABLE No. 1.

Showing quantity, intensity and energy of electric current measured at intervals of 30 seconds during a run of 2,800 feet, westerly from Lock No. 63 to Lock No. 64, through a partly straight and partly curved course, November 18, 1893.

| Observations. | Time of Start, 10.56 A. M. | | | | Remarks. |
|---|---|---|---|---|---|
| | Amperes. | Volts. | Watts. | E. H. P. | |
| 1 | 65 | 300 | 19,500 | 26.1 | Current turned on; boat at rest. |
| 2 | 60 | 275 | 16,500 | 22.1 | |
| 3 | 65 | 300 | 19,500 | 26.1 | |
| 4 | 60 | 275 | 16,500 | 22.1 | |
| 5 | 65 | 300 | 19,500 | 26.1 | Under full headway. |
| 6 | 65 | 300 | 19,500 | 26.1 | |
| 7 | 64 | 300 | 19,200 | 25.6 | |
| 8 | 65 | 325 | 21,125 | 28.31 | |
| 9 | 65 | 300 | 19,500 | 26.13 | |
| 10 | 60 | 275 | 16,500 | 22.1 | |
| 11 | 65 | 300 | 19,500 | 26.13 | |
| 12 | 60 | 275 | 16,500 | 22.11 | |
| 13 | 65 | 275 | 17,875 | 23.96 | |
| 14 | 65 | 300 | 19,500 | 26.13 | |
| 15 | 60 | 275 | 16,500 | 22.11 | |
| 16 | 60 | 275 | 16,500 | 22.11 | In this run boat was opposed by a strong head wind and by canal current. |
| 17 | 63 | 300 | 18,900 | 25 33 | |
| 18 | 65 | 300 | 19,500 | 26.13 | |
| 19 | 60 | 275 | 16,500 | 22.11 | |
| 20 | 65 | 300 | 19,500 | 26.13 | |
| 21 | 60 | 275 | 16,500 | 22.11 | |
| 22 | 65 | 325 | 21,125 | 28.31 | |
| 23 | 60 | 325 | 19,500 | 26 13 | |
| 24 | 65 | 300 | 19,500 | 26.13 | Reached Lock No. 64 at 11.08 A. M., or after 12 minutes. |
| 25 | 65 | 300 | 19,500 | 26.13 | |
| Totals | 1,577 | 7,350 | 464,225 | 621.80 | |
| Average | 63.08 | 294 | 18,569 | 24 87 | |

Average speed, 2.65 miles per hour.

TABLE No. 2.

Showing quantity, intensity and energy of electric current measured at intervals of 15 seconds during a run of 2,800 feet, easterly from Lock No. 64 to Lock No. 63, through a partly straight and partly curved course, November 18, 1893.

| Observations. | Time of Start, 11.47½ A. M. | | | | Remarks. |
|---|---|---|---|---|---|
| | Amperes. | Volts. | Watts. | E. H. P. | |
| 1 | 70 | 325 | 22,750 | 30.49 | Current turned on; boat at rest. |
| 2 | 60 | 375 | 22,500 | 30.1 | |
| 3 | 65 | 300 | 19,500 | 26.1 | Under full headway. |
| 4 | 60 | 300 | 18,000 | 24.1 | |
| 5 | 65 | 375 | 24,375 | 32.67 | |
| 6 | 68 | 325 | 22,100 | 29.62 | |
| 7 | 65 | 325 | 21,125 | 28.31 | |
| 8 | 65 | 325 | 21,125 | 28.31 | |
| 9 | 62 | 325 | 20,150 | 27. | |
| 10 | 63 | 300 | 18,900 | 25.33 | In this run the boat was favored both by wind and canal current. |
| 11 | 65 | 300 | 19,500 | 26.13 | |
| 12 | 62 | 275 | 17,050 | 22.85 | |
| 13 | 65 | 325 | 21,125 | 28.31 | |
| 14 | 63 | 325 | 20,475 | 27.31 | |
| 15 | 69 | 325 | 22,425 | 30. | |
| 16 | 62 | 300 | 18,600 | 24.93 | |
| 17 | 65 | 325 | 21,125 | 28.31 | |
| 18 | 65 | 300 | 19,500 | 26.13 | |
| 19 | 69 | 325 | 22,425 | 30.6 | |
| 20 | 65 | 300 | 19,500 | 26.13 | |
| 21 | 64 | 300 | 19,200 | 25.75 | |
| 22 | 65 | 325 | 21,125 | 28.31 | |
| 23 | 60 | 300 | 18,000 | 24.12 | |
| 24 | 60 | 300 | 18,000 | 24.12 | |
| 25 | 55 | 275 | 15,125 | 22.27 | |
| 26 | 65 | 325 | 21,125 | 28.31 | |
| 27 | 65 | 300 | 19,500 | 26.13 | |
| 28 | 60 | 300 | 18,000 | 24.12 | |
| 29 | 60 | 300 | 18,000 | 24.12 | |
| 30 | 64 | 300 | 19,200 | 25.73 | |
| 31 | 65 | 325 | 21,125 | 28.31 | Reached Lock No. 63 at 11.55 A. M., or after 7½ minutes. |
| Totals | 1,976 | 9,725 | 620,650 | 812.57 | |
| Average | 63.55 | 313 | 20,020 | 26.21 | |

Average speed, 4.24 miles per hour.

## American Institute of Electrical Engineers.

The Eighty-third meeting of the Institute will be held at headquarters, 12 West 31st street, New York city, on Wednesday, January 17th, at eight o'clock P. M. A paper will be presented by Louis Bell, Ph. D., of Boston, on "Practical Properties of Polyphase Apparatus."

By direction of council, the last report of the Committee on Units and Standards will be presented for discussion, in which is proposed the provisional adoption of the terms, "gilbert," "weber," "oersted" and "gauss." The full report will be found on page 662 of the December *Transactions*. The January issue of the *Transactions* will not be published until after the next meeting. Advance copies of Dr. Bell's paper will, if possible, be mailed upon application to the Secretary.

# ADVANCE INFORMATION.

***New Electric Companies Formed and Important Constructions Projected.***

**VALUABLE INFORMATION FOR MANUFACTURERS AND DEALERS.**

We publish below the earliest information obtainable relating to new electric railways, new electric light companies and projected electric construction of all kinds. Every reader will find these columns of special interest, and manufacturers and supply houses will receive many valuable suggestions looking to new business by carefully watching this department in the ELECTRICAL REVIEW from week to week.

### Electric Light and Power.

ST. LOUIS, MO.—R. B. Corbett, Rialto Building, is in the market for dynamo of 100 light capacity.

KANSAS CITY, MO.—A. A. Pearson, is in the market for dynamo of 500 volts capacity.

PADUCAH, KY.—A. J. Petter, 917 South Fourth street, is in the market for electric light and power machinery.

ROCKLAND, ME.—The Knox Gas and Electric Company; capital, $200,000. George E. McComber, president.

WILLIMANTIC, CONN. — The Automatic Light Company has been incorporated with a capital of $6,000, by J. L. Walden, J. Pinney and others.

VANKLEEK, ONT.—The Vankleek Hill Electric Light Company, whose capital stock was recently increased to $10,000, is booming matters in that town. They have just erected a fine new power house into which they have placed a 60 horse-power engine, three large dynamos and a generator. The latter is to be used in changing the incandescent light current, which is intermittent, to a continuous current in order that power may be furnished for motors.

### New Electric Railways.

NEWARK, N. J. — The Hudson County Board of Freeholders has granted a franchise to Jersey City, Harrison and Kearney Railroad Company to operate a railroad on the highway from Newark to Jersey City through Kearney and Harrison over the new Hackensack bridge, no engine ever to be used over the road. The company are to pay the county for the franchise the sum of $500 per annum, and the tracks are to be laid under the direction and supervision of a committee of the board.

LACONIA, PA.—The Laconia Car Company is about to engage extensively in the building of electric cars. They have at their works at present a combination car which they have the exclusive right of manufacturing in the United States. The object of the inventor of this car is to save small roads from double equipments, as it can be converted to a closed or open car at will. The company will also build ordinary electric cars, and has in view several large contracts.

### New Telephone Companies.

PERRY, O. T.—The Western Union Telephone Company has been granted a charter. Capital, $25,000; incorporators, C. P. Walker, John M. Brogan, M. Hertz, R. S. Brook and L. D. Michaelson. The company proposes to put in telephone lines between Perry, Stillwater, Pawnee and Enid.

ERIE, PA.—A charter of incorporation has been issued by the State department to the Erie Telephone Company. The capital is $10,000. The directors are: E. D. Carter, Louis Streuber, B. A. Smith, E. C. Siegel, H. C. Dunn, Erie. Attorney Rilling is the solicitor for the new company.

### Business Troubles.

DEFIANCE, O.—George W. Bechel has been appointed receiver of the Defiance Light and Power Company, of Defiance, Ohio. The application was made by the machine works and the Standard Oil Company, to whom the concern is heavily indebted. The plant comprises the gas and electric light company and street railroad, worth $100,000. Managers estimate the concern owes $30,000. The condition of the company is largely due to the failure of the savings bank, as Sauer, the cashier, was secretary and treasurer of the company.

BEDFORD, PA.—Judge Longenecker, at Bedford, Pa., has appointed a receiver for the Wyndman Electric Light, Heat and Power Company. The liabilities, it it is said, far exceed the assets.

MONTREAL, CANADA.—The John A. Grose Electric Service Company has taken action against the Holmes General Electric Protection Company for $50,000 damages for the recent seizure of their property by the Holmes Company.

ORLANDO, FLA.—The Orlando Gas and Electric Light Company has gone into the hands of a receiver, and Mr. Wm. Martin was appointed receiver.

ATTLEBORO, MASS.—A petition has been filed in Taunton for insolvency proceedings against the North Attleboro Steam and Electric Company. This move will probably result in the purchase of the line from Attleboro to Plainville by a local syndicate.

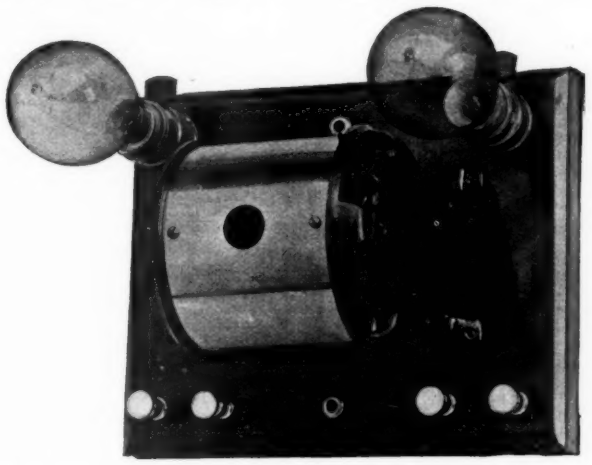


FIG. 1.—AN ACOUSTIC SYNCHRONIZER FOR ALTERNATING CURRENTS.

### An Acoustic Synchronizer for Alternating Machines.

The operation of alternators in parallel is receiving much attention, and a device to indicate in the most delicate, yet effective manner, the exact point of synchronism in speed and coincidence of phase of two alternators has become a necessity. The requirement is met by the acoustic synchronizer, which the General Electric Company has recently brought out. It consists merely of a cylindrical iron case with an aperture in the side, each end being closed by flexible diaphragms, each of which has, opposite its center, the pole of an electro-magnet. In using this device one of the magnets is connected in circuit through a transformer with each of the machines to be run in synchronism. The current is then turned into the magnet coils, and the diaphragms emit a loud clear note. As the machines approach synchronism, the notes from the diaphragms approach closer in period and begin that loud, periodic sound, known in music as beats. As the two machines more nearly approach synchronous speed, the beats grow slower and slower, until finally, the diaphragms fall into unison and each gives out the same low, clear note. At this moment, which is sharply marked, the switch connecting the two machines should be thrown in. So sensitive and distinct is the indication of approach of synchronism, that it is possible to throw two machines together with hardly a quiver upon the ammeter in actual circuit.

The superiority of this acoustic apparatus over the old phase lamp device is claimed as its chief advantage. It is said to be much more sensitive, indicating distinctly the small differences from synchronism which the phase lamp fails to detect.

The synchronizer was shown by the General Electric Company in its power and mining department at the Chicago Exposition, where it attracted considerable attention, especially from the foreign electricians. When it was shown to Prof. Von Helmholtz, and its operation explained, he expressed himself delighted. It was a development in his own field of acoustics, and showed how electricity and acoustics could work together for scientific benefit.

In the ELECTRICAL REVIEW for November 29, 1893, was fully described the three phase power transmission plant installed by the General Electric Company at Redlands, California. We are now able to show the switch board fitted up with its different regulating and controlling apparatus. The synchronizer, which the irreverent Californians have labeled the "growler," is shown in the upper left hand portion of the board. Its operation is said to be perfect, and it has not been known to fail in its functions even once.

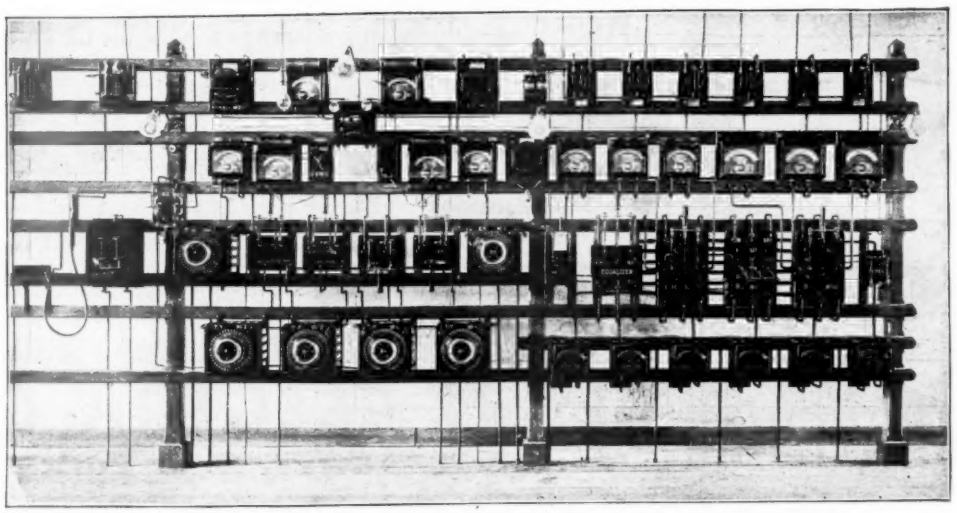


FIG. 2.—SWITCHBOARD AT REDLANDS, CAL., USING ACOUSTIC SYNCHRONIZER.

### The Headlight of the Future.

Electric headlights for locomotives will probably come into general use within a few years. Indeed, it will not be surprising if some States do not pass a law compelling companies to substitute them for the present means of illumination. Eminent authorities agree that many collisions, involving great loss of life and property, could have been averted had the engineers been able to see more than the few hundred feet lighted by the oil reflector. Several of the terrible disasters resulting to World's Fair special trains, just before the close of the exposition, were mainly due to this fact. The evidence brought out by the coroner's inquest after one of these accidents showed that the night on which it occurred was very dark and foggy, and that the train employés could scarcely see 200 feet beyond the engine's pilot. One of the engineers testified that if he had had a few hundred feet more space he could have brought his train nearly to a stop and greatly diminished the effect of the collision.

While several railway companies are experimenting with improved headlights, we believe that the Georgia Southern & Florida is one of the first, if not the first, line in this country to use electric light regularly in operating its trains. In a letter to the *Manufacturers' Record*, Receiver W. B. Sparks writes as follows:

"We have eight electric headlights. They cost about $375 each in place on the locomotive. The cost of maintenance is not greater than the oil light. An old headlight will not throw its light on a very dark night more than 150 feet, and it is impossible for an engineer to slow up his train in that distance, even with the emergency brake. The electric light throws its light from one-half to three quarters of a mile. Obstructions can be easily seen at that distance, and some of our engineers claim that a switch disk can be more easily detected by it at night than in the daytime. These lights do away with switch lights, which is quite a saving to roads that use them to any great extent.

"Railroads such as ours, running through the pine lands of the south, kill a great many cows. During our rainy season the lands along the line of road become very wet; in places they are entirely covered with water, and the cattle come upon the track seeking some dry spot on which to sleep. We have killed, when we used the old headlight, as many as 13 at one time, and our claims for stock killed per month have sometimes amounted to over $1,000. The engines using the electric headlight have never killed a cow, and I am confident that the saving in stock claims alone will more than pay for the lights within the next two years."

## KINDRED INTERESTS

**The Philadelphia Record Almanac** for 1894 is out, and is as full of interesting facts as ever.

**The Correspondence School of Technology,** Cleveland O., is very much alive, and the prospects for its success appear to be very bright.

**The Brush Electric Company,** Cleveland, O., have issued a tastefully prepared pamphlet entitled, "The Brush Electric Company at the World's Fair."

**"Lundell Motors and Dynamos"** is the title of a very artistic pamphlet just issued by the Interior Conduit and Insulation Company, 44 Broad street, New York.

**The Joseph Dixon Crucible Company,** Jersey City, N. J., have printed a little slip on "The Cost of a Lead Pencil." It is interesting and may be had for the asking.

**You ought to write** to the Page Belting Company, Concord, N. H., and ask for their new printed matter about their two World's Fair awards and medals. It's very interesting and beautifully prepared.

**The Stirling** water tube safety boiler continues to be in popular demand. One good reason may be because it gives 11½ square feet of heating surface to the horse-power. Mr. F. A. Scheffler, 74 Cortlandt street, New York, is the general sales agent for the Stirling boilers.

### A Valuable Adjunct in a Modern Steam Plant.

The Edson recorder, employed wherever steam is used, is of paramount importance, and for this reason is generally included in the specifications by the engineer or architect. Owing to its presence the firemen pay much closer attention to the firing. This results in steady steam, which means coal saved; and in this manner the recorder very soon pays for itself.

The majority of the electric light and electric street railway power plants in this country and Canada have adopted the Edson pressure-recording and alarm gauge, and in some places it has been in constant operation for over 10 years. For that matter, many of the large mills, manufacturing establishments, water works, etc., have employed their Edson recording gauge continuously for from 15 to 20 years. This instrument has an established reputation (nearing the quarter of a century mark) at home and abroad for longevity, simplicity of construction, and performing all its functions in a thoroughly satisfactory manner. And so it has become a recognized standard time and pressure-recording gauge, the records of which have been taken in court as positive evidence of the pressure carried. "It serves as an automatic superintendent of the fire and boiler room, and as an unrelaxing and incorruptible guardian of the owner's interests."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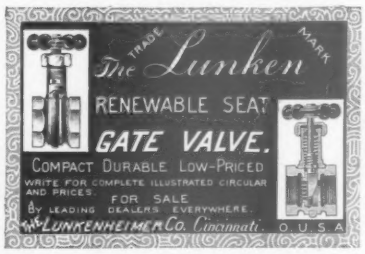


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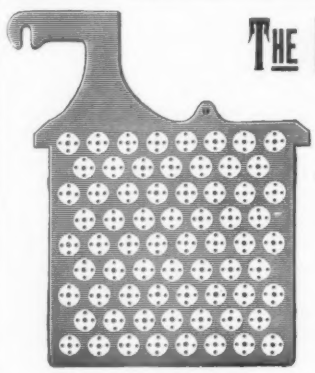
**CLARK ELECTRIC CO.**

192 Broadway, New York.



**THE ELECTRIC STORAGE BATTERY CO.**

*Drexel Building, Philadelphia, Pa.*

Sole Manufacturers of

THE CHLORIDE ACCUMULATOR.

Elements of all sizes from one pound up to one ton each.

TRACTION CELLS A SPECIALTY.

Electric Launch Equipments; Telegraph, Phonograph, Surgical and all Special Cells.